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Lighting for the Visually Handicapped

VERY naturally, the design of lighting is usually done with the " average normal " user in mind. So far as " his " visual efficiency is concerned, the requirements of this statistical individual are known with sufficient precision for design to be accomplished with considerable confidence that the planned lighting will serve its purpose well. But, of course, " populations " which—for simplicity —we so often think of as typified by an individual having characteristics " half-way " between the extremes bounding the group, do, in fact, include persons whose requirements are non-typical. This is why it is usually impossible to satisfy or please everyone equally, and why any thorough-going attempt to do so must often involve *particular* lighting—to use a term brought to our notice in May by Mr. Stuart D. Lay—as well as general lighting. The more the " population " for which we have to design differs from the general population the more need there is likely to be for particular lighting. This is true, for instance, of the lighting of homes and institutions for the elderly and it is also true of the lighting of schools for the visually handicapped or " partially-sighted." In fact, we do not know what are the lighting requirements of the " average partially-sighted person " or " *amblyope*," nor even whether the concept of such an " average " has any validity. Here, *particular* lighting is of particular importance.

Notes and News

AN ode to a piece of street furniture is not composed every day of the week. Nor does the BBC frequently allocate valuable Light Programme "time" to the subject of street lighting Hence, when architect Lionel Brett read on the air his "open letter to a lamp-post," we turned off the telly and got busy with the cat's whisker. And it seemed to us that Mr. Brett was peddling some ideas nearly as out of date as steam radio. Now, no one rivals *Light and Lighting* in its concern that street-lighting columns should be well designed (not even the *Architectural Review*), but good design did not end fifty years ago.

Mr. Brett, we should explain, was mourning the loss of "the dark shadows and mysterious corners" of "the village" which, we are told, is now to be lit by new lamp-posts which Mr. Brett addresses thus: "You are twenty-five feet high, concrete with knobs on; you have a curved neck, and from your beak hangs a glass casserole which at night gives out a painful stab of deathly green light."

As we all know, "contemporary," like freedom, is always for other people and designers of modern buildings always seem to live in quaint old-world villages with equally quaint old-world lighting. Not that we don't sympathise with Mr. Brett regarding the *colour* of the light and, not having seen the columns to which he refers, we cannot say whether they are likely to earn a *Light and Lighting* 'Oscar.' Nevertheless, we cannot agree that the adequate lighting of main roads through villages and small towns should be held up solely to provide "mysterious corners" where things can "go on" (Mr. Brett apparently fears that nothing will "go on" when main roads are better lit) or (another of Mr. Brett's worries) to prevent lamp-posts from dominating the snaps taken by foreign tourists.

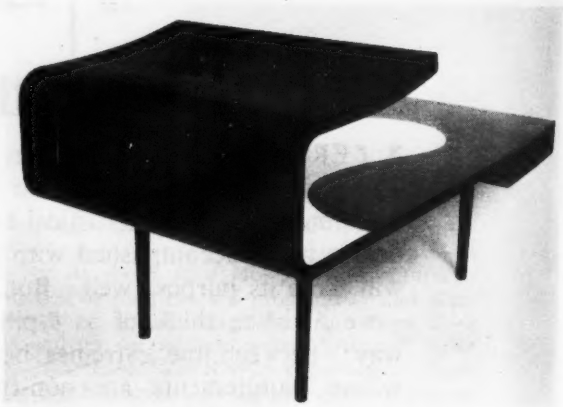
New Light on Industry

The British Electrical Development Association has recently introduced a new film on industrial lighting entitled "New Light on Industry." Running for some thirty minutes this film takes the audience, with a narrator, on a tour of industrial plants and stresses the relationship between good lighting, good industrial management and high productivity. It includes scenes shot in twenty-five industrial locations, in small as well as large factories. At the première, Lord Chandos, who is also featured in the film, said: "Good factory lighting is something about which I am very keen. For many years one of my companies has been giving a free optical service and very cheap spectacles to those who work for it, and our welfare officers say that that is the most acceptable of all the amenities which we give. That means that there are a very large number of people who work in factories who work with inadequate lighting, and one of the ways in which we can reduce eyestrain is by providing good lighting." We were particularly interested in this film, which has arrived at the time when we are in the process of putting together a comprehensive feature on industrial lighting due for publication later this year. We hope that this feature, as the EDA film, will help to convince industrialists that well-lit factories are essential for giving greater industrial productivity. All lighting engineers should see the EDA film and then arrange for it to be shown as widely as possible to those concerned with industrial welfare, management and productivity.

Furniture and Lighting

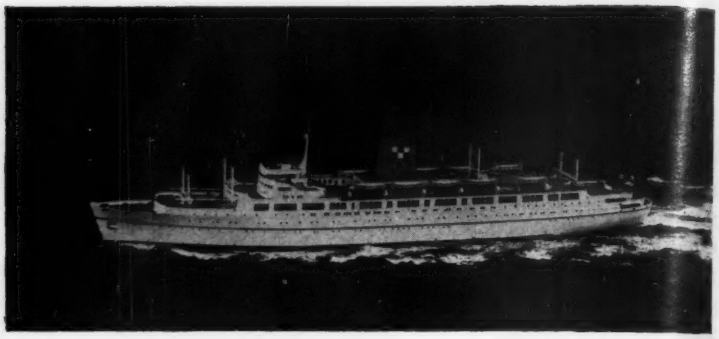
On show in London recently was an exhibition (now on view at the Regent Street headquarters of Thomas De La Rue and Co., Ltd.) of furniture demonstrating the use of that versatile and almost indestructible plastic sheeting "Formica."

The exhibition, which includes items for the home,



the office and the hotel bedroom, is of wide appeal, but one piece of furniture is of particular interest to the lighting engineer. This is a coffee table designed by Sir Hugh Casson and Timothy Rendle (and made by D. Burkle and Sons), which is unusual in that it has a built-in light. Occasional tables combined with floor standards or table lamps are by no means uncommon; what is (so far as we know) unique about this one is that the lighting is completely integrated with the design of the table itself.

Opened recently in Tottenham Court Road, London, W.1, were extensive showrooms for the Marley Tile Co., Ltd., manufacturers of wall, floor and roof tiles, plastic piping, precast beams for floor and roof construction, wood-wool insulation and prefabricated concrete garages. The showrooms were designed by Howard V. Lobb and Partners, F./F.R.I.B.A., in collaboration with James Gardner, O.B.E., R.D.I., and a variety of display techniques includes extensive use of the firm's own products. Above and right are two views of the ground floor of the premises, which are lit by glass-covered "portholes" recessed into the panels of the suspended ceiling, by the decorative pendants seen on the right of the photograph above, and by spotlights directed on to the various displays. The inquiry desk is emphasised by rows of naked tungsten lamps partially recessed into the canopy above it.



The Empress of England

The Canadian Pacific Steamship Company's latest passenger liner for the North Atlantic service

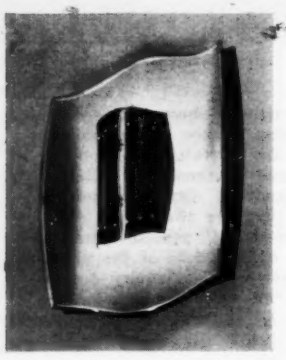
THE latest passenger liner to join the famous Canadian-Pacific fleet, the *Empress of England*, is a sister ship to the *Empress of Britain*, of which illustrations were published in *Light and Lighting* for December, 1956. Her gross tonnage is 25,000; her length 640 ft.; and she carries her 1,058 passengers and crew of 464 at an average speed of 20 knots. She was built by Vickers-Armstrongs, Ltd., launched by Lady Eden, and commenced her maiden voyage to Montreal on April 18, 1957.

In accordance with current trends, nearly 90 per cent. of the accommodation on the ship is tourist class, the remainder being first class, though the tourist accommodation, particularly the public rooms, is fitted out in such a manner as to make it virtually indistinguishable from the first-class areas of the ship.

The hull of the *Empress* is painted white, with a green riband from stem to stern; her single funnel is buff and the " boot-topping " is green. Below the boat and promenade decks there are five decks, excluding the hold, the after decks being arranged in echelon. There is only one mast, this being an integral part of the navigating bridge. Its broadened base houses machinery for the first-class lift. There are no guys or stays, the only visible wires being the wireless aerial and the signal halyards, and, the ship being air-conditioned throughout, there are none of the old-fashioned bell-mouthed ventilators which are such a familiar feature of ships' architecture.

In addition to enclosed promenade decks and the restaurants for both classes, the following accommodation is provided: first class—sun lounge, garden lounge, drawing room, club room, library and children's room. Tourist class—lounge, smoking room, cocktail bar, writing room, library and children's playroom. Shared between both classes are the Empress room, the cinema and the swimming pool. Ancillary accommodation includes a launderette and ironing room, barber's shop and beauty salon, various shops and, of course, the administrative offices.

The public rooms of the ship are lit mainly by indirect light from cold-cathode tubing, much of it concealed in troughs formed by variations in ceiling levels. Cold-cathode tubing is used also in continuous glass-covered fittings arranged in relation to the architectural features of the rooms. More direct lighting comes from louvred downlights recessed into the ceilings. Most other types of fitting are in evidence, including table lamps, floor



Extreme left, lantern-type wall bracket used in the tourist cocktail bar. It is made of gilt-bronze, houses a 60-watt lamp and has a conical glass shade. Left, wall bracket in gilt-bronze and red enamel used in cinema. It houses a 60-watt lamp. Right (top), the Empress room. The shallow dome in the centre is lit by cold-cathode tubing in four colours controlled by colour-change apparatus. The downlights house 100-watt lamps, have perforated rims of gilt-bronze, and are covered with stepped glass lenses. Right (bottom), tourist-class restaurant. Cold-cathode lamps are concealed by the lowered area of ceiling and above the perforated suspended fittings. Additional light comes from a variety of downlights and from bronze and walnut wall brackets with shades of perforated cream plastic.

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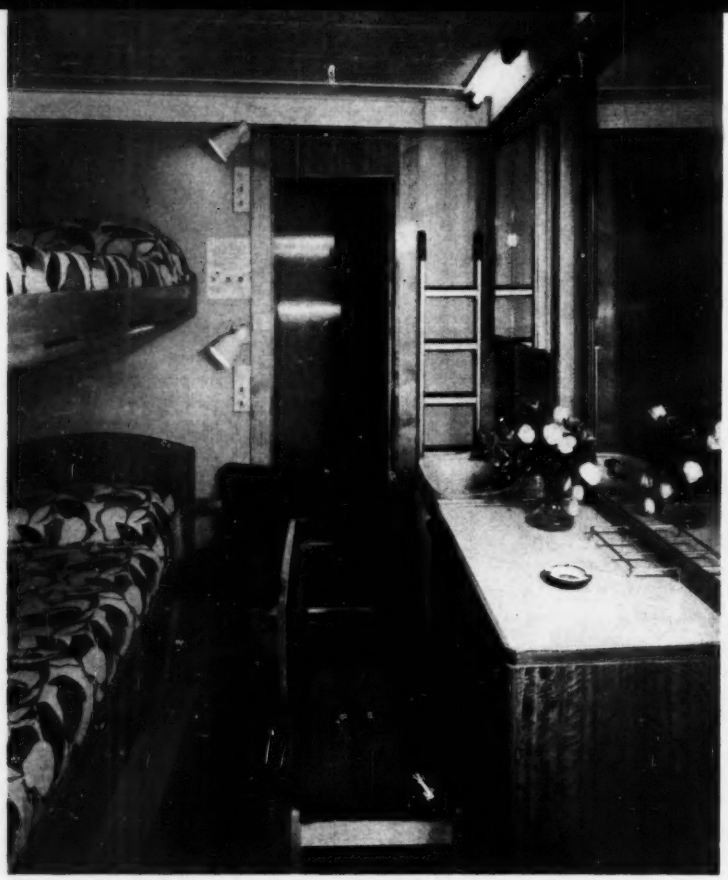
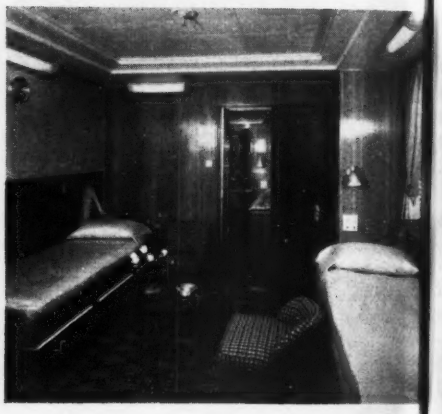




Cabins: tourist class (left) and first class (below). Lighting in both is from 110-volt instant-start fluorescent lamps arranged in series of two, using current-regulator tubes as ballast. In the first-class cabins and suites the lamps are in fittings with "Perspex" covers. In the tourist-class cabins they are housed in simple batten-type fittings. Over each berth, in both classes of accommodation, is an adjustable reading lamp with a spun-metal shade.

standards and wall brackets, and it is said that there are no less than 100 fittings of special design.

Apart from a row of opaque trough fittings suspended a short distance below the ceiling of the tourist dining saloon (see photograph on page 203), there are no pendant fittings, as, in common with other passenger liners, ceiling levels are a good deal lower than in rooms of comparable size ashore. The indirect system of lighting, coupled with the "architectural lighting," was chosen because the numerous obstructions, such as ventilation ducting and service pipes, concealed in the space between the ceiling and the deckhead make it difficult to recess lighting fittings into this space and virtually impossible to arrange them in symmetrical patterns.

The cold-cathode lighting is provided by a combination of ivory and gold tubing, of which there is in all over two miles, the switching being arranged so that, when desired, either colour may be used independently. In certain rooms, such as the Empress room, there is tubing of four colours (red, green, blue and de-luxe warm white), controlled by automatic colour-change apparatus.

One additional point of general interest is that most of the lighting fittings are made of bronze alloys—Delta II (a silver bronze) and Delta IV (a gilt bronze)—to avoid the necessity of using plated finishes.

Cabins are lit by instant-start hot-cathode lamps, using current-regulator tubes as ballast, supplemented by reading lamps with spun-metal shades over each berth. In the first-class cabins the fluorescent lamps are housed in fittings with "Perspex" covers; in the tourist cabins there are simple batten-type fittings. The electricity supply voltage is 220, the 110-volt fluorescent lamps being arranged in series of two.

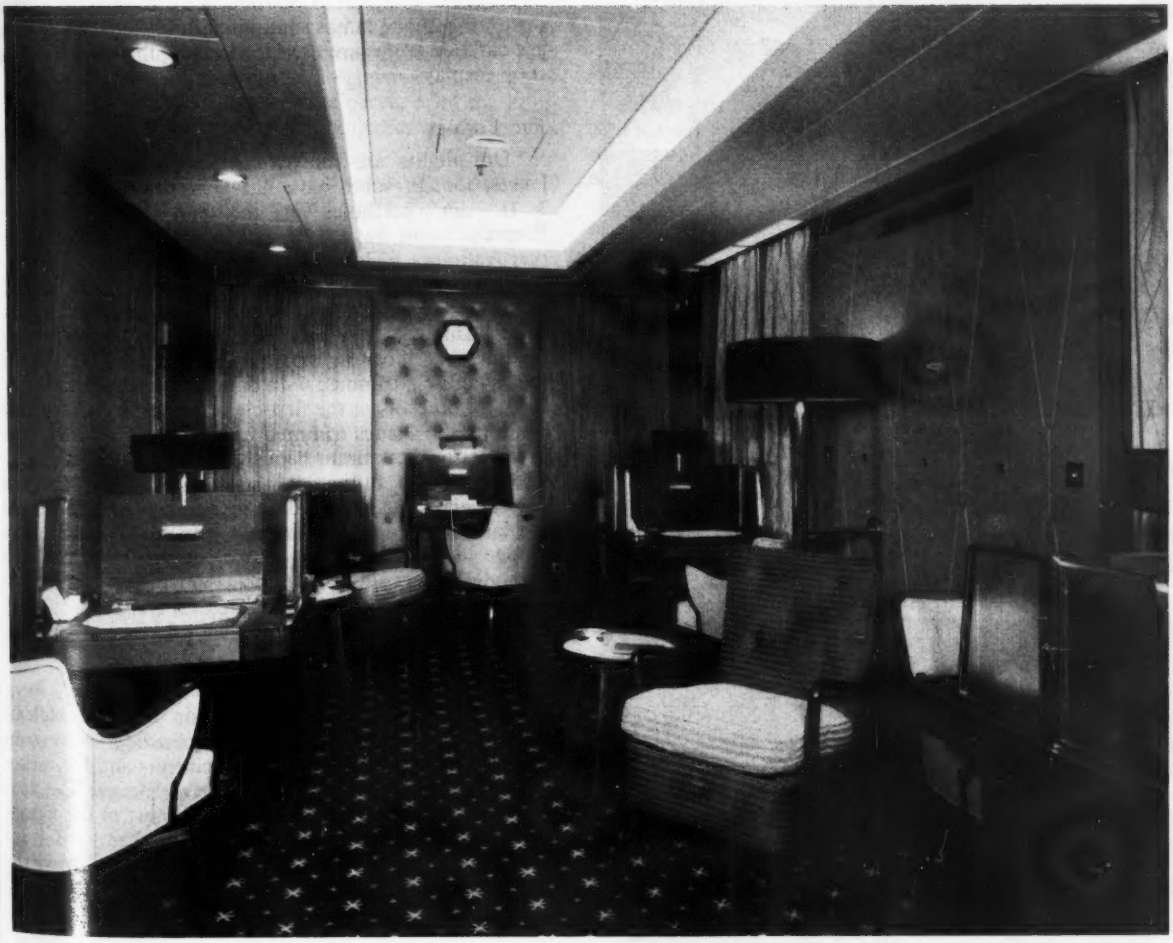
Public Rooms

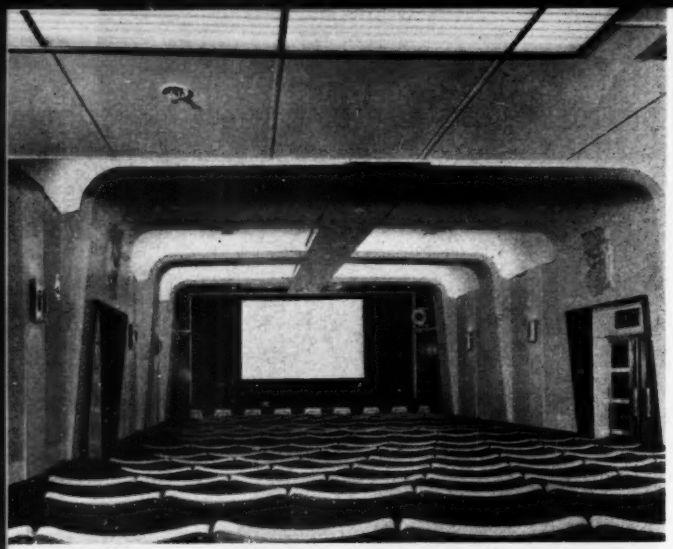
In addition to general lighting from concealed sources and continuous glass-covered architectural features, there are, in the first-class sun lounge, standard lamps in gilt-bronze and walnut; 3 ft. 3½ in. dia. "porthole" fittings, with "Perspex" covers, recessed into the ceiling; and 18 in. dia. "lanterns" in gilt-bronze with glass shades. In the first-class restaurant there are 7 in. dia. louvred downlights housing 60-watt tungsten lamps, and wall brackets in bronze and rose zebrano each holding two 60-watt lamps. Supplementary lighting in the drawing room includes 5 in. dia. downlights, floor standards housing three 60-watt lamps, and table lamps in gilt-bronze and ebony.

Lighting in the first-class library comprises cold-cathode tubing in fittings recessed or semi-recessed into the ceiling; floor standards (as described above); wall brackets of similar design; and reading lights over each table.

A variety of downlights has been used in the tourist restaurant, the smallest being only 5 in. dia. and housing a 25-watt lamp, while the largest, 15 in. dia., has a glass cover and a perforated bronze rim, and houses a 100-watt lamp. In addition there are wall brackets of gilt-bronze and Rhodesian walnut. In the tourist lounge, apart from concealed cold-cathode tubing, there are floor standards and small downlights. The smokeroom is similarly treated, though there are, in addition, eight three-light wall brackets. More floor standards are used in the

Right, tourist-class writing room. The suspended ceiling conceals cold-cathode tubing; into it are recessed three 13-in. diameter downlights housing 40-watt lamps covered with flat glass discs. Desk lights of gilt-bronze also house 40-watt lamps. Below, first-class library. Light from concealed cold-cathode tubing is supplemented by a row of downlights and by floor standards of bronze and walnut, with shades of pleated blue silk bound with black plastic. Fixed to the desks are fittings of gilt-bronze with similar shades to those of the floor standards.





Top, the cinema. Concealed cold-cathode tubing is controlled by a motor-operated resistance dimmer and supplemented by light from downlights and from the wall brackets illustrated on page 202. Centre, part of promenade deck lit by "Perspex" covered fittings each containing two 2-ft. 20-watt instant-start fluorescent lamps with their stabilisers. Similar fittings are used in the hospital and operating theatre. Bottom, children's playroom. Cold-cathode fittings in ceiling recesses are supplemented by 5½-in. diameter downlights housing naked 40-watt lamps and by 10½-in. diameter ceiling mounted glass bowls housing 60-watt lamps.

cocktail bar, as well as the lantern-style wall fitting seen in the close-up on page 202.

Cold-cathode lighting in the cinema is controlled by a motor-operated resistance dimmer under push-button control. This is arranged so that the gold tubing is switched out during the first moments of dimming, the ivory then being dimmed alone before being switched out, too. Extra light comes from downlights and wall brackets, the latter—of gilt-bronze and red enamel finish—housing 60-watt tungsten lamps.

Lighting in the swimming pool includes an underwater fitting of white stove-enamel housing four 60-watt lamps; special lighting for the promenade deck comprises "Perspex" fittings each housing two 2 ft. 20-watt instant-start hot-cathode lamps; and miniature (4-, 6- and 8-watt) hot-cathode lamps are used for lighting the showcases and shop displays.

The Fittings

Downlights are mostly covered with stepped glass lenses, though some have flat glass discs and the large 3 ft. dia. portholes in the sun lounge and the Empress room have "Perspex" covers with concentric corrugations. Floor standards have shades of pleated silk or buckram in a variety of colours, trimmed with matching or contrasting velvet, leatherette or plastic. Table lamps, too, have pleated silk shades with velvet binding, but those in the tourist library have shades of blue shantung, trimmed with dark blue plastics binding.

Wall brackets in the first-class restaurant have pleated white plastic shades trimmed with white leatherette; those in the tourist restaurant being of perforated cream plastic. The three-light fittings in the tourist smokeroom have conical glass shades standing in cups of gilt-bronze, and the lanterns in the cocktail bar, sun lounge and garden lounge also have shades of opal glass. Recessed cold-cathode fittings in the tourist lounge and cinema are covered with panels of corrugated "Perspex"; other fittings of this type being covered with flat glass.

Designers and Contractors

Architects for the ship's interior were A. McInnes Gardner and Partners. The lighting installation was designed in collaboration with the architects and the various furnishing contractors by the General Electric Co., Ltd., who also designed and manufactured most of the lighting fittings. Other lighting fittings were supplied by Best and Lloyd, Ltd., and Philips Electrical Ltd., who also supplied the instant-start fluorescent lamps used mainly in the cabins.

Classroom Lighting for Partially Sighted Children

By A. DUBOIS-POULSEN*

Proper classroom lighting is important to all school children but is of even greater importance to those with only partial sight. This article analyses the visual difficulties of such children and makes recommendations for suitable lighting.

Good lighting is certainly one of the most important factors in workers' comfort, but, where amblyopic children are concerned, it is the prominent one, since the major difficulty is for these subjects to use their poor-sighted eyes. Lighting is therefore a more important problem for them than for the normal schoolchild. The ophthalmologist is the only one able to determine the kind and amount of light the amblyopic child needs. The purpose of this article is to discuss the physiological aspects of the question and the technical requirements.

In the French legislation, children whose visual acuity is inferior to 3/10 but superior to 1/20 are classed as amblyopic. Amblyopia means " blunt sight " and it may be due to lesions of the anterior segment of the eye ; to lesions of the retina, or of the optic nerve, or of the intracranial visual pathways ; or to anomalies of the oculomotor apparatus.

The following is a list of the diseases encountered in the classrooms for amblyopic children in Paris.

(1) Ametropia
  (a) simple myopic condition or associated with astigmatism ;
  (b) ametropia of other varieties.
(2) Associated congenital malformations.
(3) Congenital cataracts.
(4) Nystagmus.
(5) Albinism.
(6) Optic atrophy.
(7) Corneal diseases.
(8) Infantile glaucoma.
(9) Leber's disease.
(10) Toxoplasmosis.
(11) Pigmentary retinal degeneration.
(12) Ocular affections of unknown reasons.

It is therefore impossible to give a universal formula for lighting, but it will always be necessary to meet particular needs by using individual lights in addition to general lighting. Some amblyopes, however, e,g., albino children are not always able to benefit from the great amount of light necessary to others.

Estimation of the Visual Difficulties in School Work

Distance

The work in schools is among the most diversified that one can imagine. It is known that Weston classifies different visual tasks by their distance from the eye. " Teloramic work " is far from the eye (over two metres), " mesoramic work " means a medium distance, " ancoramic work " is close to the eye (under 50 cm.). The schoolboy must read on the blackboard at a long distance, draw at a medium distance, read and write at a short distance. Therefore, good general lighting of the classroom must be provided. But amblyopia complicates the situation. Many pupils have no accommodation (after a congenital cataract operation, for instance) ; some have a lack of convergence ; others a very narrow visual field which does not allow them to see objects which are fairly wide apart. Children must therefore be placed in the schoolroom according to their visual abilities and after a consultation between the eye specialist and the teacher.

Size

The visual sizes of print used by the school children are well known and the visual acuity required to read may be easily estimated. It depends on the size of the down stroke and on the reading distance. Amblyopic children use books especially printed for them in large characters which need only a low acuity (1/10 or 2/10). Teachers know that they must write in very big letters on the blackboard. A visual acuity of 1/10 corresponds to letters of 7 centimetres at 5 metres and of 14 centimetres at 10 metres with a width of 15 millimetres. Therefore pupils are not visually overstrained. Many objects are sketched or drawn by the teacher himself so that they are more convenient to the children. Printing must be of good quality with plain and uninterrupted lines.

The lighting norms for normal people are all calculated from the curves showing the variation of acuity according to illumination. The best-known curves are Lythgoe's and Weston's. (Fig. 1.) In France, we use Haas and Couvreux's which are in lux. Ten lux are necessary for a visual acuity of 1/10 (in English units about 1 lm/ft² to obtain 1/6). But it would be a mistake to conclude that 10 lux is all that is needed by amblyopic pupils because their vision is limited to 1/10 or 2/10. The child who strives to make use of weak sight with a poor visual acuity needs more light than normal individuals who have 10/10 vision.

So as to form a personal and accurate opinion on the subject we went through Haas and Couvreux's tests with their own apparatus specially designed to determine the curve of visual acuity as a function of the illumination. But instead of studying normal people we dealt with amblyopic children. Haas's apparatus has a luminous window on which are shown Snellen's types of various sizes. The luminance of the window may be altered beginning with very small threshold values. After a dark

* Ophthalmologist of the Quinze-Vingts, Paris.

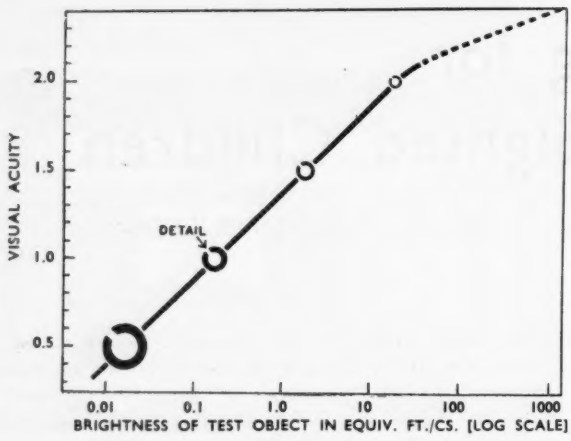


Fig. 1 (above). Weston's representation of Lythgoe's acuity v. brightness curve.

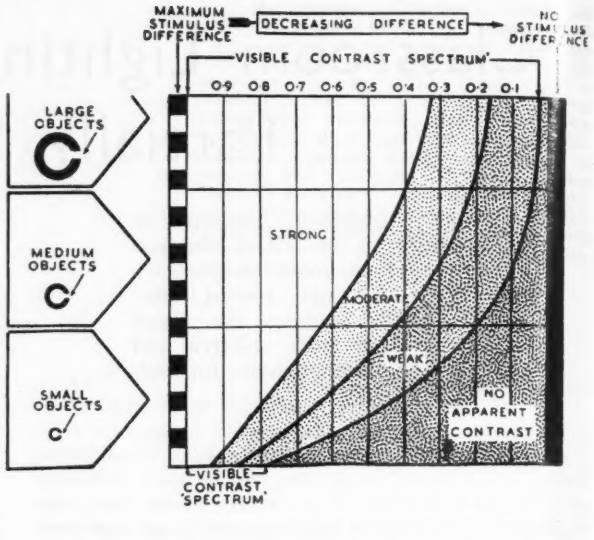


Fig. 2 (right). Weston's diagram of contrasts.

room adaptation of 45 minutes the perception of the window is determined, i.e., the absolute light threshold. Each Snellen's test is then presented to the eye and the amount of light necessary to see the break in the various rings is noted; a curve is drawn.

The majority of our amblyopic children had practically a normal absolute threshold, although for acuity of 1/10 it was necessary to give them an amount of light much higher than that needed by normal children for 10/10 vision. The conclusion is plain; the amblyopic child needs a lighting level much higher than the normal.

At this point it must be said that fatigue occurs very quickly with lighting exclusively based on the bare acuity required for accomplishment of the work. The work should not demand more than a third of the maximum available visual acuity. Weston recommends that if possible the illumination used should be sufficient to give a visual acuity twice as high as the minimum demanded by the task. So we are compelled to increase the quantity of light given to amblyopic children.

Contrast

Form acuity is not all in perception. Contrast between the object and the background is a prominent factor of visibility. Amblyopes, with their poor vision, rely especially on the help of contrast, and this should be excellent. Printing must therefore be on very black or very white paper.

The lighting engineer must keep in mind the law of contrast: the smaller the size of the text the greater the importance of contrast. The visible contrast "spectrum" is larger with big size objects and narrower with small ones. (Fig. 2.) High values of illumination facilitate perception of small contrasts since the brightness-difference threshold is smaller at these levels. Low illumination is prejudicial.

How do amblyopes see contrast? A high contrast allows them good perception but their visual impairment makes them insensitive to small brightness differences. This fact may be demonstrated by showing them a Broca's disc and asking them to count how many rotating dark circles they can see on the white background. Graduated grey spots on a white background may also be used to measure their contrast sensitivity. It is very variable since diverse diseases are met with in amblyopic children; but it is always poor for small contrasts.

As the brightness of surfaces depends upon their reflection coefficients it will be necessary to take special care in the choice of mural paintings and especially in the paper and print of reading books and pictures to be used by amblyopic children. But, even so, a considerable amount of light is needed.

Colours

Perception of colours is not abnormally poor in amblyopic children except in the case of congenital dyschromatopsies which, however, are not more frequent than among those who are not amblyopic. Amblyopes use very beautiful colours when they are asked to do a water painting. They make up accurate reproductions and very suitably coloured harmonies. Sometimes their style may be harsh but this is a characteristic of children's paintings more than of amblyopic disability. Nevertheless their colour perception is modified. They can make a good classification of the Polack's colour test when the hues are well saturated. But the clear pastel desaturated hues are not perceived and they are confused; the amblyope does not make any distinction between them. This is a peculiar feature of acquired dyschromatopsies. Farnsworth's test, which is the classification in continuous series of numerous hues with the same brightness, is very badly performed. The amblyopic child gets out of difficulties with colours by appreciating the brightness contrast. Hue is not always necessary to separate between two colours. High illumination levels improve colour contrasts. It is therefore necessary on this account to increase the amount of light given to the amblyopic pupil.

Other Factors

Many other factors must not be neglected. Perception of a moving object is impaired in bad lighting. In the schoolroom objects do not move but many children have nystagmus and this has the same effect as movement of objects.

The stereoscopic sense is bad in a great majority of

amblyopes. It is necessary to intensify lights and shadows so that the appearance of relief or solidity should be dependent on contrasts and should be appreciable by monocular vision.

Lighting Installations and Illumination Levels

The needs of amblyopes for their visual comfort may be summarised in a few words. A level of illumination higher than for normal people and better contrasts are required. Amblyopic eyes are more susceptible to bad light conditioning, especially to glare. At positions where the general illumination may be inadequate there should be local lights so that every pupil may use them at his own will.

Subject to the foregoing, the laws for good lighting are the same for amblyopes as for other people. According to Weston we may give the following summary :—

(1) There must be a sufficient amount of light on the task-objects.
(2) Sufficient illumination of objects within the surrounding visual field is needed.
(3) The spectral composition of light must be suitable.
(4) The arrangement of light sources must be suitable.

Both daylighting and artificial lighting must be considered, the former being the more important.

Daylighting

It is evident that schoolrooms for amblyopes should be set up in new buildings in which architects have realised excellent daylight illumination, with very large windows along a whole side of the room and extending up to 20 cm. from the ceiling and down to the floor level, or at least to the same level as the working tables. The total window area should be more than a quarter of that of the floor. The building should be on an open unobstructed site.

In general, natural illumination of a room is defined by the daylight factor, i.e., the ratio between illumination on a given point of the room and illumination outside the window on a horizontal plane $T=\frac{E}{E_0}$. It is supposed to be constant whatever may be the external illumination. A common value is 5 per cent.; a 20 per cent. factor is very good. But there are rooms with single small windows in which it is impossible to obtain more than 1-2 per cent.

Partially sighted pupils must be placed in rooms the daylight factor of which is not lower than 5 per cent. But this, in itself, is not sufficient. The illumination near the window is better than that in more remote parts of the room. (Fig. 3.) Pupils must be placed according to their need of light, and no one should be seated at a distance from the nearest window greater than twice the height of the window, as measured from the sill.

Lighfoot in his book recommends the building of schoolrooms for amblyopes in bungalows so that it is possible to have windows in the roof and obtain a constant illumination at every working position. This solution should also work on the top floors of school buildings. However, one must beware of high summer temperatures.

Local or general artificial lighting may supplement

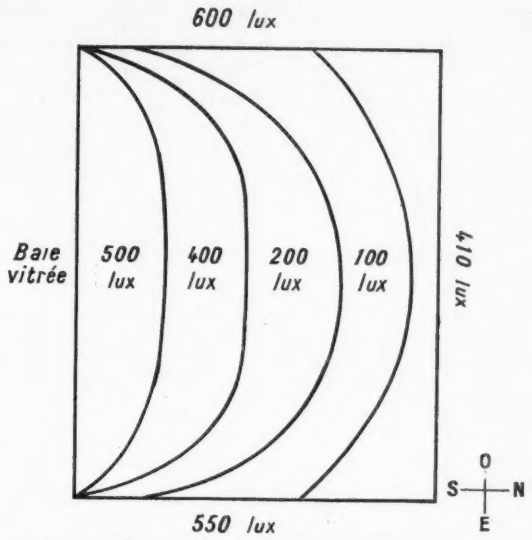


Fig. 3. Distribution curves of daylight illumination in a schoolroom for partially sighted children in Paris. Numbers outside the frame represent illumination of the walls. (March 15, 3 p.m.)

inadequate natural lighting, but mixed lighting is never the best. In certain schoolrooms in France, the artificial lights must be used constantly, but this is a very bad solution.

Artificial lighting

Here again, laws and problems are not different. In the case of normal individuals, norms have been deduced from practical experiences and laboratory researches. There has been no investigation concerning partially sighted children, but it should be easily carried out with statistical studies of visual performance as a function of illumination. Charts of Landolt's broken rings might be used for this purpose.

Errors are functions of visual acuity, of attention and also of contrast and illumination. Reading speed is another test which should give useful information. Tests of observation or visual attention should be applied. These may consist of symbols printed on paper, some being different from others by one detail. The pupils have to recognise and indicate selected symbols. Thus it is easy to get an idea of visual acuity and of the necessary illumination. What we know already is that with amblyopes the speed of reading diminishes and the percentage of errors increases faster when illumination is lowered than with normal individuals. When this suggested investigation is done among partially sighted pupils we are sure to get very scattered results because of the very diversified diseases involved. Weston's scales give a right notion of results in normal individuals. They may be used as well for partially sighted children on condition that only the values given for poor contrasts should be used, even though the task actually involves good contrast. The amount of light then needed is 500 lux or 50 lm/ft² if one takes account of the individual variations, following Weston's and Broca's Laws dealing with fatigue. For a comparison the levels of illumination in British and Belgian schools for normal children are given in Table I.

Table I

Levels of illumination in British and Belgian schools for normally sighted children.

	British lm/ft²	Belgian lm/ft²
Lecture rooms	7	25 (minim. 15)
Classrooms, Laboratories	15	25 (minim. 15)
Drawing, Sewing	20	40 (minim. 25)
Libraries	15	25 (minim. 25)

A distinction, however, must be made between the luminance of the panorama and the ergorama, i.e., the surroundings and the task area. Great differences between the two must be proscribed, although they must not be equal. In a completely dark room a bright ergorama would create glare but if the panorama is brighter than the ergorama attention is always distracted from study.

The general (panoramic) illumination must not be less than the square root of the local illumination on the work, both values being expressed in lumens per square foot. In no case should the general illumination be less than 6 lm/ft². In French units, taking 500 lux as the work illumination, the general illumination should be at least 60 to 70 lux.

There are, however, two stumbling blocks—cast shadows and glare. Partially sighted children are more susceptible to the effect of both of them than are normal children.

We said that supplementary illumination is needed on the table of every pupil, so that the illumination due to the general lighting may be brought up to each individual's needs. The local lighting fittings must be fully and easily adjustable and the lamps themselves invisible. Many partially sighted children take defective postures, they read or write very close to the text, bending their back, the nose almost in contact with their books. Their heads cast shadows on the book and the light must pass between the head and the paper. In some schools big lenses are mounted on the table and the illumination comes from under the lens. This is a good solution. Owing to the heat produced, high wattage lamps are dangerous for amblyopes who are always very close to their work; 60 watts seem to be a sufficient amount. Furniture, desks and so on should be movable: pupils must not be bound to a fixed position in the room.

Glare is more injurious for partially sighted eyes than for normal ones. Among the reasons for this may be the absence of the light reflex because of a surgical iridectomy, or the absence of the crystalline lens which is a natural filter in the intact eye. Mention may also be made of retinal or choroidal diseases, and of pigmentary degeneration in which there is disturbance of light adaptation. Naked light sources must be proscribed; screens are necessary and their positions in the visual field must be such as to screen from view any light source situated within an angle of 25 deg. with the axis of the eye when the eye is raised from the table and is directed to the blackboard or at the teacher.

The question of the blackboard is a vexed one. Every student knows that with a worn board the reflection ceases to be diffused and becomes an especially dazzling and disturbing specular one. It is a question of angle between light direction and board plane. But what is the remedy? It may be a better surface. Dark green boards have been proposed and used with yellow chalk so as to give a strong colour contrast besides the brightness contrast. Such boards do not seem to be much better in ordinary service. White boards with a slightly convex surface on which charcoal is used instead of chalk should avoid specular reflection. There are also boards in ground-glass illuminated by "black" light on which one writes with fluorescent pencils. But, pending the production of better boards, it is necessary to give good lighting to those available. The more diffused the artificial light, the less disturbing is the specular reflection.

Special lighting must be provided for the blackboard because this is a "working plane" and therefore should not have only the same illumination as the environment. The larger the room the higher must be the illumination of the chalkboard. For a maximum viewing distance of 10 metres an illumination equal to rather more than half the value recommended for individual desks is necessary; 25-30 lm/ft² is a good average. Wall charts should be treated in a similar manner.

Board environment must be considered. What must be prominent is the contrast between chalk and board surface. If the reflection coefficient of the wall is too high there will be a very high contrast between a blackboard and the wall and this will lower the apparent contrast between chalk and board. Therefore, the wall on which the board is fixed must not be too light in colour. A hue which is restful for the eye, e.g., green-blue, is desirable.

This latter consideration deals with reflection coefficients of the walls and with environment colours. The lighter the wall, the higher the reflection coefficient, and the better the lighting efficiency. Weak contrasts are adopted for normal children and it must be the same for partially sighted pupils. It does not matter what they have to do. Fig. 4 shows reflection coefficients as used in American schools. Table 2 gives the reflection factors recommended in the Belgian code for school lighting and Table 3 gives the recommended brightness ratios given in the same document.

A lot has been written on the subject of colours for interiors. Clear pastel hues give a greater light efficiency, but their choice is not determined by precise psychological laws, as is wrongly written everywhere. The aim should be to produce a harmonious setting pleasant to look at, but what this may be is largely a question of taste.

The amblyope's poor perception of unsaturated hues does not matter. But where a colour contrast can indicate some useful things very well, e.g., clothes-pegs, door knobs, it should then be exaggerated. The general environment may be as for normal individuals. However, too near an approach to uniformity should be avoided. American schoolrooms may be criticised for giving an impression of such uniformity as to be more favourable to rest than to intellectual effort.

A final controversial question still remains. What source of light should be chosen; incandescent or fluorescent? In France, because of adverse criticism against fluorescence, the Ministry of Health waited and for a long time did not authorise fluorescent installations in schoolrooms. But a report of the French Academy of Medicine stated that this light is excellent when the installation is properly carried out. Fluorescent light is nowadays used in French schools. Both methods of lighting have their advantages and disadvantages. With

Fig. 4.

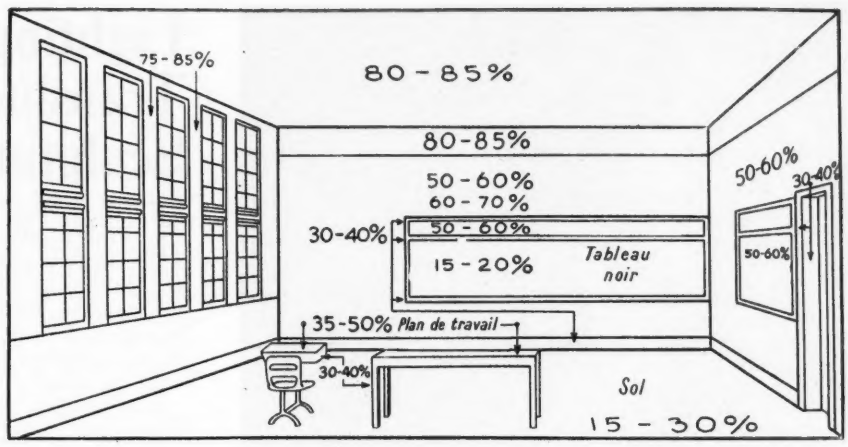


Table 2

Recommended Reflection Factors (Belgian)

Ceiling	70 to 80 per cent.
Upper part of the wall	60 to 70 „ „
Lower part of the wall	40 to 50 „ „
Floor	more than 30 „ „
Wall with blackboard	45 to 55 „ „

Table 3

Brightness Ratios (Belgian)

	Max.	Permissible
(a) Between the centres of the visual field and the adjacent surfaces of the desk	3	1
On blackboard	1	1/3
(b) Between the centre of the visual field on the desk and the dark adjacent surfaces in the visual field (floor)	1	1/10
(c) Between the centre of the visual field on the desk and the light adjacent surfaces (walls)	10	1
(d) Between the lighting units, the windows and the adjacent surfaces in the visual field	20	1

fluorescent lighting beautiful effects may be produced and in particular one may realise luminous ceilings, which suppress cast shadows and give a day-like environment. But a good installation of incandescent light sources also gives a suitable environment.

Four objections are chiefly made to fluorescent lighting. They are :—

(a) Rhythmic periodic variations of the luminous flux give a stroboscopic effect which is very tiring for the eyes, but the twin-lamp (out of phase) system or operation of the lamps on a three-phase supply are good remedies.

(b) The spectral composition of the flux gives a poor imitation of daylight. It is characterised by two maxima, one in the long, the other in the short wavelengths. But, owing to its chromatic aberration, the eye has difficulty in focusing these different wavelengths simultaneously. So, accommodation falls into a panic because it is pulled from one chromatic " pole " to the other. Visual acuity has been said to be worse under an equal luminance with fluorescent than with incandescent light. Baumgardt and Pieron established that visual acuity is worse in blue light than in white, red, yellow or green light. This criticism may have some importance in the case of partially sighted children.

(c) Fluorescent light is produced by an electric discharge in mercury vapour and consequently emits u.v. rays. Are they dangerous to the cornea and conjunctiva ? In fact, u.v. rays are filtered by the envelope of the tube, although exposure to the lamps at very close range should be avoided.

(d) Fluorescent lamps may be dazzling. But glare is possible with incandescent lamps, too. Both must be equipped with diffusing screens.

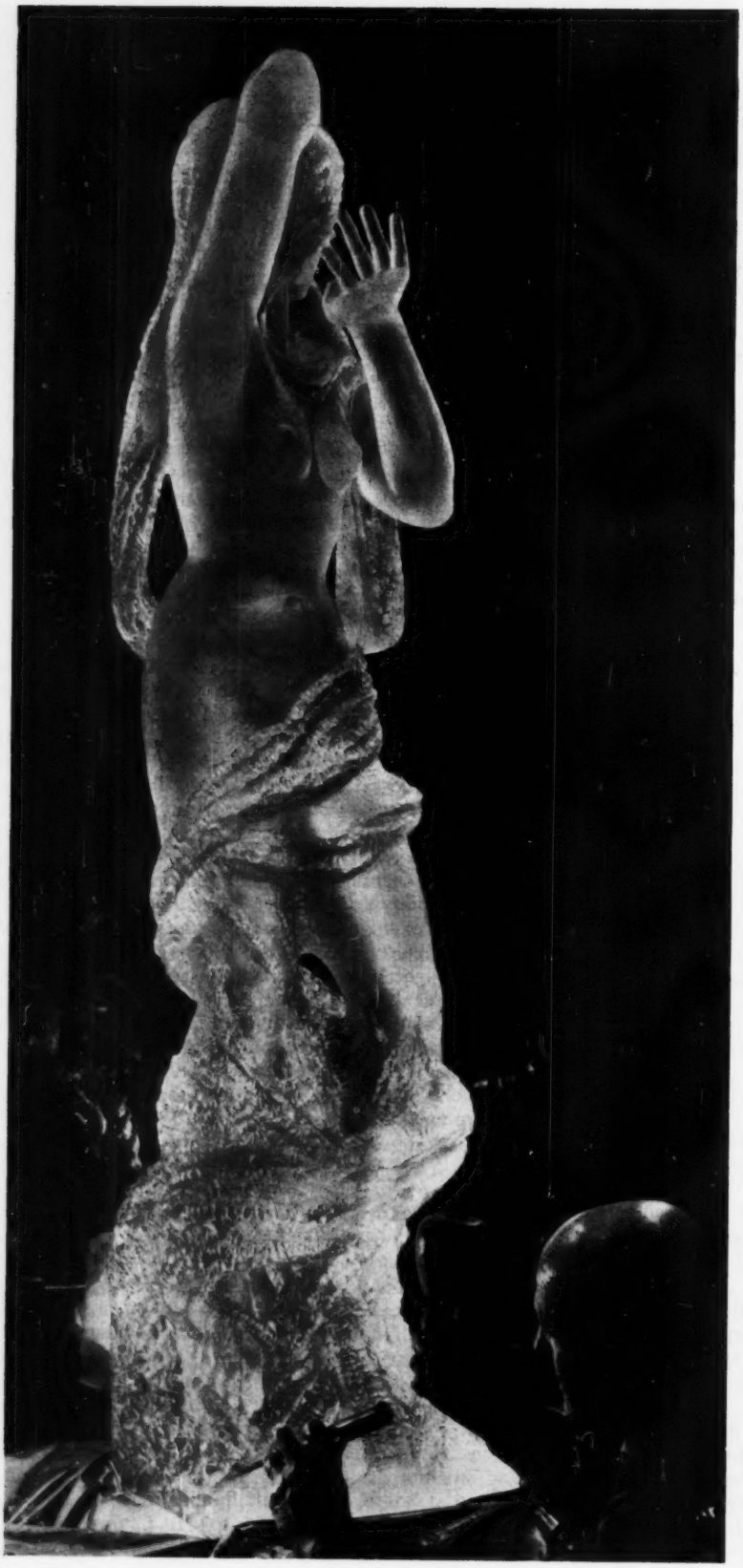
In all these considerations there is no real objection to fluorescent lighting in schoolrooms. The partially sighted sensibility calls for good lighting, but there is no particular illuminant to be proscribed. What can be said is that fluorescence or incandescence may be used for general lighting but that it may be an advantage to use incandescent lamps for supplementary local lighting.

A last recommendation must be made. Installations must be periodically checked and maintained in good order. Dust and long service lowers illumination levels. Aged fluorescent lamps switch on badly and flicker. Lack of maintenance is the worst thing in lighting service.

Conclusion

The above article may be summarised in a few words. Partially sighted children have low visual acuity and need a great amount of light to work at their best. They have poor discrimination for weak contrasts and desaturated colours. Therefore, it is necessary to provide high work illumination levels—about 50 lm/ft^2; environmental illumination should not be less than 6 lm/ft^2. One must pay particular attention to the distribution so as to avoid undesirable contrasts. Incandescent and fluorescent light may be used. The major difficulty is the great individual diversity in the numerous ocular affections of the children. A good help in this disconcerting situation is individual local lighting in addition to a good standard of general illumination.

Acknowledgement is made to H. C. Weston for permission to reproduce Figs. 1 and 2 in this article.



Lighting Translucent Sculpture

THE lighting of sculpture is a subject about which, so far as we have been able to discover, very little is known—particularly in this country. We know of no experimental work in this field except that of photographers, whose needs are of a special nature.

It is obvious that the successful display of any three-dimensional work of art depends considerably on appropriate and carefully arranged lighting. But it becomes even more important when the work is carved from a translucent material. Arthur J. Fleischmann—a sculptor who has travelled from his native Czechoslovakia through Europe, Africa, Australia and the Pacific islands, working in a variety of media—has, of late, specialised in the use of translucent material for his work. His first experiments took place in Australia, where shortages of suitable media for his sculpture led him to try a semi-translucent local stone.

Since settling in the United King-

dom eight years ago, he has carried out a great deal of work in "Perspex," including a number of mythical figures, an altar screen, a triptych and a Calvary group. In using this material Dr. Fleischmann considers right from the start the way in which his works are to be lit—by natural or artificial light; from behind, from below or from the edges—and in some he has chiselled right through the material so that the free-standing elements of the sculpture are completely flooded with light and appear to glow with an inner luminosity of their own.

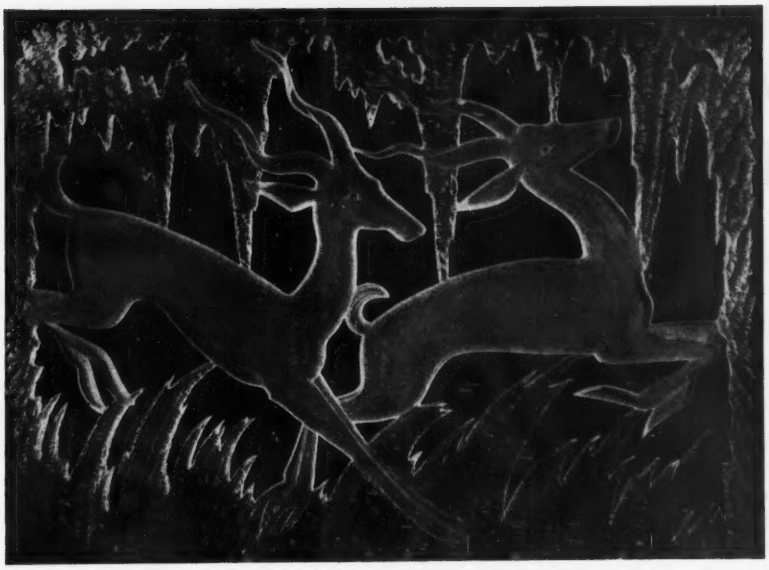
But let the sculptor speak for himself. This is how Dr. Fleischmann explained the lighting of his work to a member of our staff:—

"The problem in connection with my sculptures, carved in solid 'Perspex,' is usually that the carving is done in the natural light of the studio, though from time to time controlled by the light of lamps, but when the statues are placed in their permanent positions, the right artificial lighting has to be found. This can be achieved without difficulty by lighting them with hidden lamps from under the base, or from the back, or by so-called edge-lighting. This varies according to the size, shape and position of the object.

"In the case of 'Lot's Wife'—a 6 ft. carving, now exhibited in Holland Park—the problem was different. This statue is placed in the open and has no artificial lighting. However, the light outdoors is different from the studio light. This being the first piece placed in the open air, I took it first to a garden, and it was a most exciting experience to see how well the material reacted to the daylight—and, in particular, to direct sunlight.

"In the open the sculpture shows different aspects, according to the position of the sun and its intensity. It has what one of the critics has described as 'a life of its own.' Moreover, the facets reflect some of the colour of the surroundings—the greens of the trees and the lawn, the blue of the sky, and so on. Some people I have talked with hardly believed me when I told them that the material was colourless.

"I should add, in this connection, that the material can, of course, be lit in any colour artificially, but this I mostly find unsuitable and not altogether in good taste."



Above, a decorative panel of two antelopes carved in "Perspex." In this work, Dr. Fleischmann has cut right through the material so that the light, which comes from behind and to the sides, can completely engulf the figures. Below, a "three-dimensional" panel of the heavens. The various elements are carved or engraved into several layers of "Perspex," and the whole work is lit only from the edges.

Dr. Fleischmann's most recent work—"Lot's Wife"—is unusual in that it is intended to be seen in daylight rather than artificial light. The photograph on the left was taken at the LCC's Sculpture Exhibition in Holland Park, London, where the work is now on view. The photographs on the facing page (taken exclusively for "Light and Lighting" by John Pantlin) show the very different appearance of the same piece of sculpture lit artificially in the artist's Mayfair studio.

A Spherical Chart for Simplifying the Design of Area Floodlighting Schemes

The design of area floodlighting schemes by conventional methods can be very tedious. This article describes a simpler method of design which has been used with success.

By G. K. LAMBERT, B.Sc., (Eng.), A.C.G.I., D.I.C.*

Whereas the floodlighting of vertical surfaces of buildings is a matter of artistry, an objective level of illumination with diversity tolerances is often specified for area floodlighting installations such as those for sports stadiums, railway marshalling yards and docks. Projectors for this type of application can be divided into two classes, viz : (a) those used at one particular angle of tilt, with a light distribution to suit, and covering an area dependent only on mounting height; and (b) those in which the angle of tilt is adjustable so that any particular area can be covered by the beam or beams of one or more projectors.

Fixed Angle Projectors

A method of installation design for use with fixed-angle projectors was developed in the BTH Research Laboratory by J. C. Lowson in 1946. A projector of this type is shown in Fig. 1; the installation design data is given in Fig. 2 in the form of " lumens per square " of a horizontal grid. The side of the squares is dimensioned in terms of the mounting height so that one set of figures applies for all mounting heights. For comparison the conventional iso-foot-candle diagram is also given in Fig. 2.

Mean values of illumination are obtained by multiplying the " lumens per square " figure by a constant factor dependent on mounting height. In the example the side of the squares has been made equal to half the mounting height. The chart indicates that the projector directs 610 lumens into the area represented by the second square in the third row. When the projector is mounted at 100 ft. the square represents an area 50 ft. x 50 ft. and the average illumination is $\frac{610}{50^2}$ or 0.24 lm/ft². If the projector is at 50 ft. mounting height, this square represents an area 25 ft. x 25 ft. and the average illumination is $\frac{610}{25^2}$ or 0.98 lm/ft². This figure agrees with the iso-foot-candle diagram on the right which is for 50 ft. mounting height, most of the area of the square lying between the 1.1 and 0.7 lm/ft² contours.

When two or more projectors are used their charts are, in effect, superimposed in the correct relationship and the " lumens per square " figures for the overlapping squares are added together.

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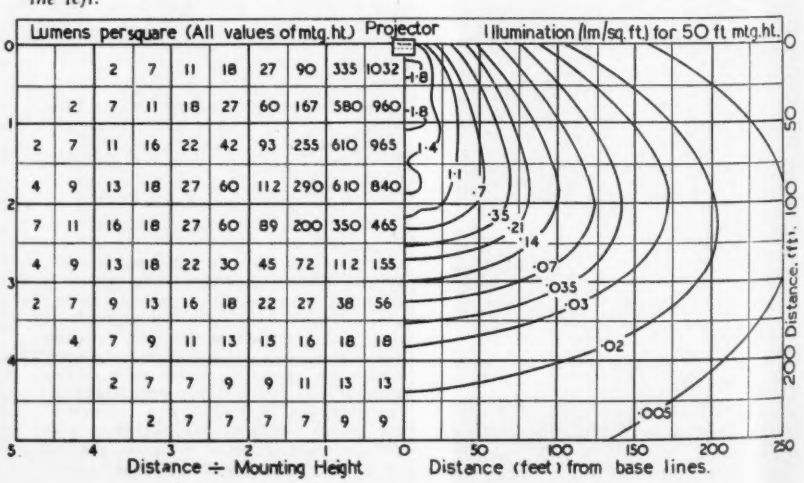
Fig. 1. An area floodlight designed to give uniform illumination at a particular angle of tilt.

Fig. 2. Installation design data for the floodlight shown in Fig. 1. The area illuminated is symmetrical about the centre line of the figure. Iso-foot-candle contours for a mounting height of 50 ft. are shown on the right for comparison with the data on the left.



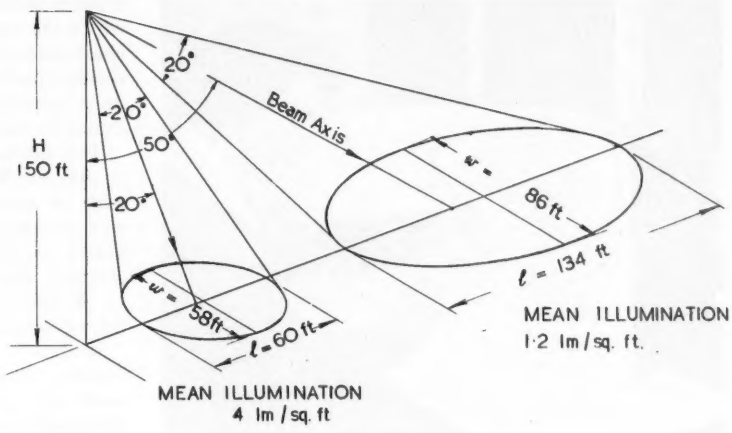


Fig. 3. Variation with angle of tilt of the area covered by a floodlight beam. The data is for an 11,000-lumen beam of uniform intensity over 20 deg. about the beam axis.

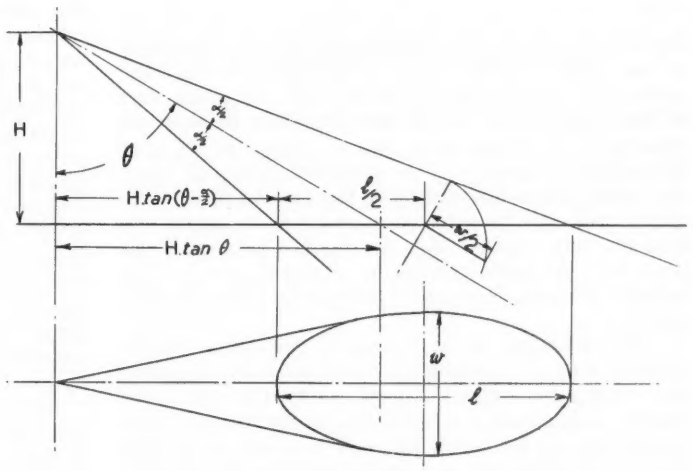


Fig. 4. Simple geometrical construction for determining the width of the light patch on the ground from a symmetrical beam projector.

Adjustable Projectors

Calculations for adjustable projectors are complicated as the beam coverage varies according to the angle of tilt, as shown in Fig. 3, as well as with mounting height. Iso-foot-candle diagrams or "lumen squares" for all angles of tilt for a range of projectors and lamp sizes would be unmanageable especially as this type of projector is usually of medium or narrow beam type of distribution.

In Fig. 4, θ is the angle of tilt of the projector axis from the downward vertical, i.e., the DV angle. The simplest case is considered of a beam of circular cross section and of total angle α with a uniform intensity I in all directions within the beam. The projector illuminates an elliptical patch on the ground extending over a distance l from a point at $H \tan (\theta - \frac{\alpha}{2})$ to one at $H \tan (\theta + \frac{\alpha}{2})$ from the point under the projector. It should be noted that the greatest width of the patch is at the mid-point of l which is not the point distant $H \tan \theta$ from the tower at which the projector is aimed, but is farther away from the tower.

The width w can be calculated or obtained graphically as follows. The elevation in Fig. 4 includes the projector axis. To find the half width of the patch at any point, draw the normal to the beam axis through that point in the elevation. The intercept of this with the conical surface bounding the beam gives the radius of the beam in the plane including that normal. If the arc is drawn as shown (Fig. 4) representing the boundary of the beam in a plane normal to the paper, the half width $\frac{w}{2}$ can be measured as the length of the line from the point to the arc, parallel with the projector axis.

The area of the patch illuminated is $0.785\ wl$ and the mean illumination in the patch is

$$E = \frac{L}{0.785\ wl} \text{ lm/ft}^2$$

where L is the beam flux. Except when θ and α are small the actual illumination varies considerably from the mean and it may be necessary to calculate the illumination at a range of points, as $E = I \frac{\text{Cos}^3\ \theta^1}{H^2}$ where θ^1 is the angle of the direction of such a point to the downward vertical.

For points along the major axis of the patch allowance can be made for variation of the intensity at different

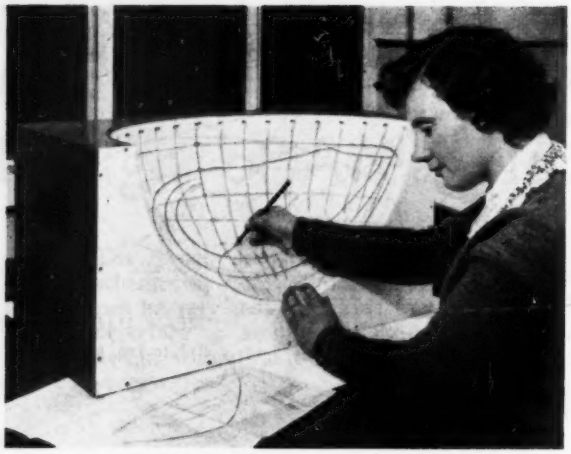


Fig. 5. Use of spherical chart. The area of a sports stadium, as viewed from a corner tower, has been transferred to the chart preparatory to planning the installation.

angles from the axis of a symmetrical beam by measuring off the angle from the centre of the beam ($\theta^1 - \theta$) and reading the corresponding intensity from the polar curve of light distribution. For points other than those on the major axis an ellipse must first be drawn in the plan through such a point with the same ratio and with major and minor axes superimposed on those of the patch. This ellipse need only be sketched in as far as its intersection with the major axis so that the angular distance of the point from the beam axis can be measured, and the light intensity directed to the point determined from the polar curve.

This indication of the process of calculation for the simplest type of symmetrical beam projector illustrates the considerable amount of work involved in installation design. Calculation is not difficult but the trial and error process can be laborious, and it is not easy to envisage the best projector size and light distribution in the early stages.

The Spherical Chart Method

A method of planning has been developed which enables a rapid appreciation to be made of the type of projector most suitable and after deciding on the arrangement to be used makes it possible to calculate rapidly and precisely the illumination at any required point. The method involves the use of a special spherical chart on which the area to be illuminated is drawn in outline. The chart differs from the sinusoidal web used for plotting iso-candle-charts for street lanterns only in that it is formed on a spherical surface which avoids the distortion introduced by the sinusoidal web.

The property of this chart which makes it so useful is that the beam coverage of a projector does not vary with its angle of tilt. A templet of the beam coverage of a projector can thus be made and applied to the area drawn on the chart as often as required to build up a specified illumination.

A chart is shown in Fig. 5, engraved on half of a hemispherical shell blown from a thick sheet of opal "Perspex." A diameter of 2 ft. makes working convenient. It is mounted so that the spherical surface subtends the centre point 180 deg. in azimuth, from the horizontal to the downward vertical, every 10 deg. in azimuth and vertical being marked.

It is first necessary to choose the positions and heights of the towers on which the projectors are to be mounted. The next step is the transfer of the plan area to the spherical chart in terms of the angles at which the boundaries are seen from the chosen projector position and mounting height. The angles may be determined as indicated on the left in Fig. 9. Radial lines are drawn on the plan from the position of the projectors at intervals of 10 deg. from any chosen reference direction. (Additional lines at other angles may be necessary to locate the directions of specific points.) The length of these lines to their intercepts with the boundary of the area (or other features) is measured and the "downward vertical" angle to the boundary in the appropriate azimuth direction is calculated as $\tan^{-1}$ (length $\div$ mounting height to scale). These points are then plotted on the appropriate azimuth lines on the sphere and the boundary contours drawn in.

An alternative graphical procedure is indicated on the right in Fig. 9. In an elevation the mounting height is marked in, to scale, perpendicular to the 0 deg. azimuth reference direction. Lines at selected DV angles intersect this base line to give the corresponding distances from the foot of the tower which may then be drawn in as an arc. The position of the boundary in terms of DV angles and azimuth can then be seen, e.g., in Fig. 9 the boundary crosses the -10 deg. azimuth direction at 79 deg. to the DV.

If a level of illumination (E lm/ft^2) is specified, the

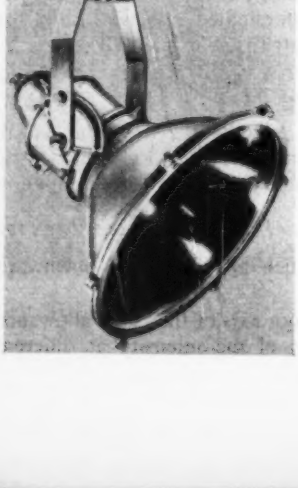


Fig. 6 (left). A narrow beam floodlight for area lighting from high towers.

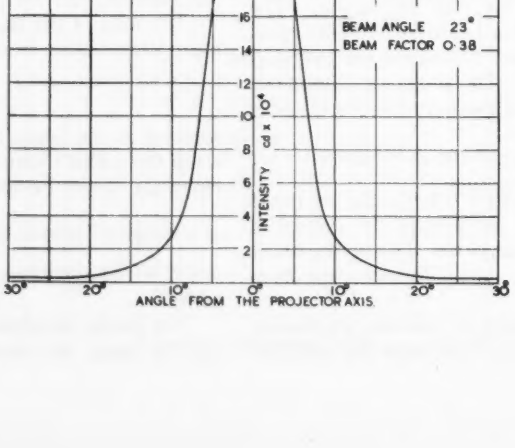


Fig. 7 (right). Polar curve for the projector shown in Fig. 6.

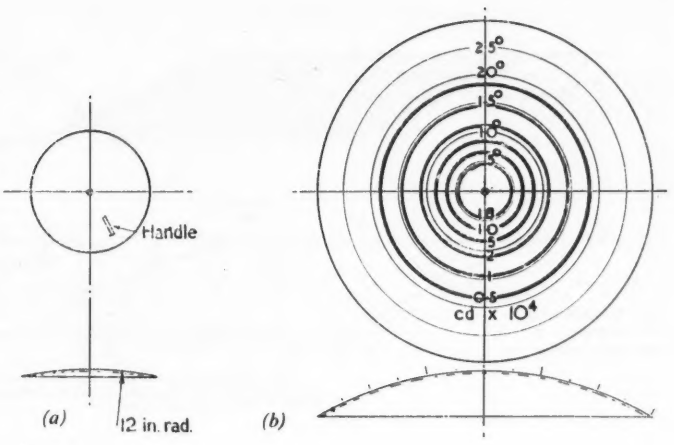


Fig. 8. Templets of the beam from the projector shown in Fig. 6. (a) The templet for outlining the coverage of a single projector beam is a transparent disk subtending 23 deg. on the spherical chart; (b) A transparent isocandle diagram of the beam which enables the intensity in any given direction to be read off by interpolation when calculating the illumination at chosen points.

total intensity (ΣI cd) from a group of projectors to produce this illumination at an angle θ to the DV is

$$\Sigma I = E \frac{H^2}{\mathrm{Cos}^3\,\theta} \text{ cd}$$

This can be calculated for a number of values of θ and either drawn as a graph against θ or marked on the chart at convenient values of θ.

Bearing in mind factors such as running hours per annum and any colour limitations, the most suitable light source and projector is chosen to suit the angular size of the area and the required intensities. A reassessment should now be made of the area that can be covered from the selected projector position, taking into account the angular size of the area. At angles approaching 80 deg. DV the intensities required rise steeply and wastage may become considerable so that it may become more economical to put up another tower. The take-over can also be visualised: if two towers are used, each will probably contribute half of the illumination at the take-over point and will make some contribution to points beyond.

Before the layout of projectors can be planned a templet of beam coverage is required. What this comprises is best understood from an example. Fig. 6 shows a modern narrow-beam projector for a 1½-kw. metal filament lamp which is used for area floodlighting from high towers. Fig. 7 shows its light distribution in rectangular co-ordinates. This data can be transformed into a templet such as the disc of beam angle (23 deg.) shown in Fig. 8. This is a disc to the same angular scale as the spherical chart and may be conveniently dished to the same curvature as the chart and provided with a hole in the centre for marking through the direction of aim.

This templet is used for the preliminary layout of an installation. For the more precise calculations of illumination at selected points the templet may take the form of an isocandle diagram transparency. Provided the angular scale is the same as that of the spherical chart, the isocandle diagram can be drawn about the downward vertical direction, as in Fig. 8, or at any other angle such as the example in Fig. 11.

Planning the layout consists of superimposing the contour of the selected projector on the area so that each part is covered enough times to build up the required total intensity at that DV angle. It is a trial and error process and the layout and overlapping of the beams to get the most economical arrangement requires a degree of art and experience. The process is not, however, as laborious and tedious as conventional methods.

Example of an Installation Design for a Railway Siding

Railway sidings are usually irregular in plan and often fully occupy the width of a site, so that the only available space for a tower is at the ends. A simplified layout is shown in the upper part of Fig. 9. The angular projection which would be drawn on the spherical chart has, for purposes of illustration, been plotted on a sinusoidal web at Fig. 10. The sinusoidal web is convenient for explaining the method, but except for long, narrow areas at one DV angle or close to the 0 deg. azimuth line, or for very small angles of α, is no substitute for the spherical chart owing to distortion. As often happens in practice, although more than one tower may be used, there are axes of symmetry which make it unnecessary to draw more than one view of the area on the chart.

Suppose an illumination is required on the horizontal plane of 1 lm/ft² and the projector shown in Fig. 6 is to be used.

From Fig. 7 the beam angle is 23 deg. and the beam factor is 0.38, corresponding to a beam flux of approximately 11,000 lumens. The average intensity in the beam

$$I = \frac{L}{2\pi(1 - \mathrm{Cos}\frac{\alpha}{2})}$$

$$= 90{,}000 \text{ cd (or for convenience 90 kcd)}$$

The peak value of 180 kcd extends over approximately ± 5 deg. The total intensity ΣI required at various angles θ to produce the illumination (E) of 1 lm/ft² is calculated as $\Sigma I = E \frac{H^2}{\mathrm{Cos}^3\theta}$ and is marked at the corresponding values of θ to the right of the 0 deg. azimuth line on Fig. 10. The number of projectors required to cover all points at each angle is this total intensity divided by 90 kcd.

At 45 deg. and below the intensity from a single projector is more than is needed, and to avoid wasting light slight defocusing together with a spreading front

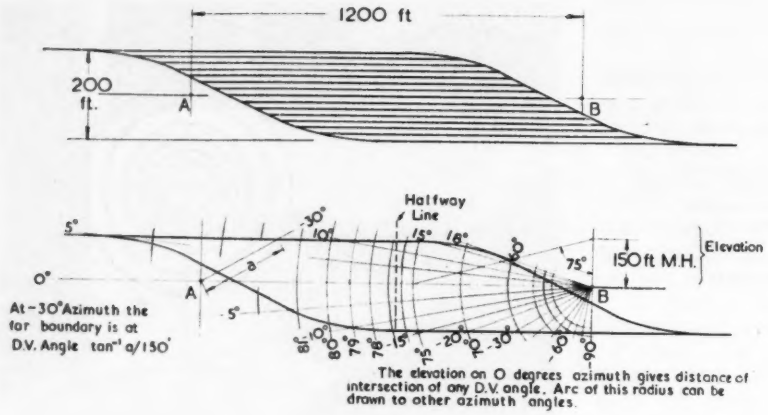

1200 ft
200 ft.
A
B
Halfway Line
Elevation
150ft M.H.
At -30°Azimuth the far boundary is at D.V. Angle tan⁻¹ a/150'
The elevation on O degrees azimuth gives distance of intersection of any D.V. angle. Arc of this radius can be drawn to other azimuth angles.

Fig. 9. Layout of sidings indicating positions of 150-ft. towers and alternative methods of determining the angular co-ordinates of its boundaries, for transfer to the spherical chart.

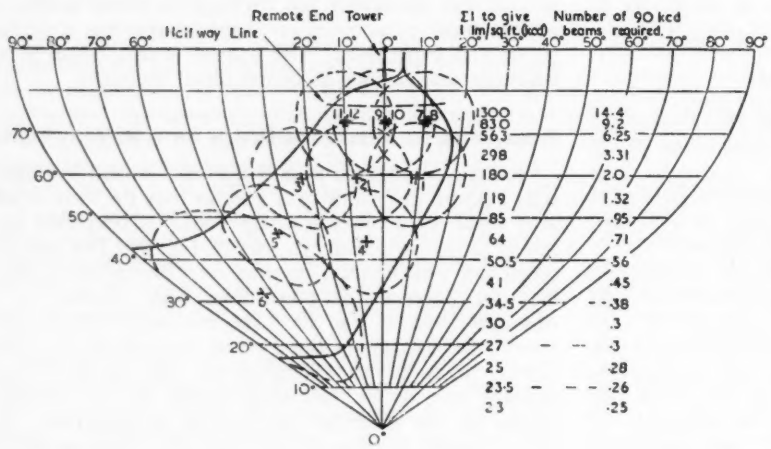


Fig. 10. Layout of installation for the sidings shown in Fig. 9, transferred from spherical chart to sinusoidal web. (The beam or bright patch contours are circular on the spherical chart and are distorted by the sinusoidal web; projector No. 6 is defocused and spread to a 40 deg. beam; the remote tower contributes 50 per cent. of the illumination at the halfway line; planning of projectors 1, 2, 3 and 7—12 is based on a 180 kcd. intensity over the central 10 deg. of the beam.)

glass, or a diffusing reflector, may be used to cut down the peak intensity to 25 kcd.

At values of θ over 75 deg. an excessive number of projectors is required and the area concerned will be mainly illuminated from the tower at B. In this region there will be seen to be considerable waste light—calculations here would be based on the peak light intensity of 180 kcd rather than the average.

Check on the actual illumination at specific points

After deciding on the layout the actual illumination at any chosen points can readily be calculated. It would be possible to locate the centre of the isocandle templet at the point representing the direction of aim of each of the adjacent projectors (i.e., those contributing to ΣI at a chosen point) and read off by interpolation the intensity at the point. When the beam is symmetrical, or symmetrical about two axes, the same values are obtained by centring the templet on the chosen point and reading off the intensity corresponding to the directions of the projectors. Illumination then is

$$E = \Sigma I \frac{\mathrm{Cos}^3\ \theta}{H^2}$$

Other types of projector

The spherical chart saves considerable labour in designing installations for the symmetrical beam projector, but is even more valuable when projectors such as that shown in Fig. 11 are used. The parabolic section reflector with a 400-watt MA/U lamp gives a distribution concentrated in a vertical plane and spread over about 90 deg. horizontally. With the spherical chart the templet of this isocandle diagram can be "fitted" to the area to be illuminated with the greatest of ease, as shown in Fig. 12.

Photometric data for this type of projector is usually supplied in the form of polar curves of candlepower distribution in two perpendicular planes, the one plane including the axis of symmetry of the beam and the lamp axis while the other is normal to the lamp axis. A close approximation to the isocandle diagram can be determined by assuming that the ratio of intensity $I\psi$ at any angle ψ from the axis of symmetry of the beam to the intensity I_o in that axis is constant for all planes including the lamp axis, for that value of ψ. The isocandle diagram for the 400-watt projector shown in Fig. 11 was deduced

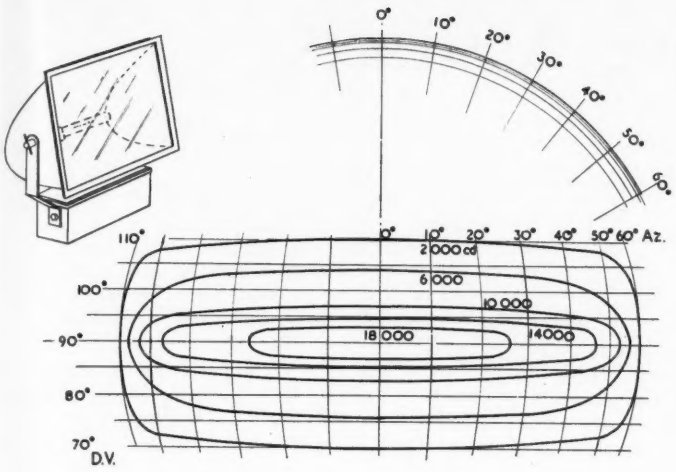


Fig. 11. Templet of isocandle diagram for axially symmetrical beam from a projector using a 400-watt MA/U lamp in a parabolic-section reflector.

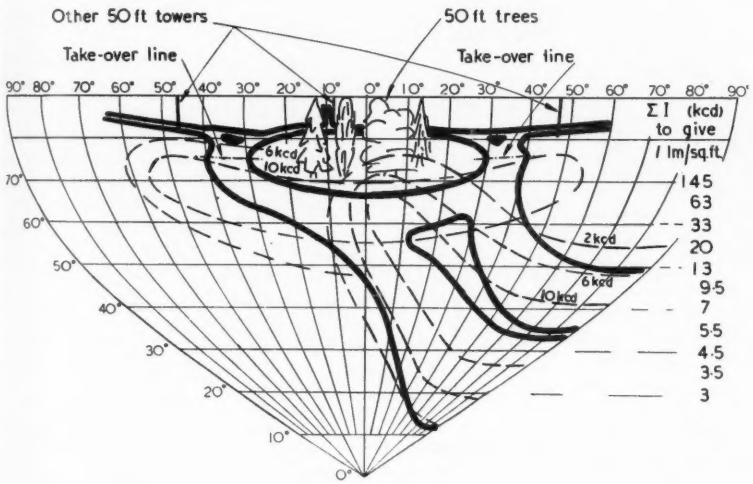


Fig. 12. Four-road roundabout viewed from one 50-ft. tower, transferred from spherical chart to sinusoidal web. (The beam of the floodlight referred to in Fig. 11 has been applied to the approach road and to the roundabout. In both cases the shape of the beam is eminently suitable, but for the roundabout itself intensities are low and a similar projector using a 1-kW. MA/H lamp is indicated for this section. The distortion of perspective and beam shape is due to the sinusoidal web.)

in this way and made into a templet by plotting it on to a transparent spherical shell of the same scale as the chart.

Areas other than horizontal

The chart is not limited to flat areas: for sloping or stepped areas it is just a question of correcting H for each point and allowing for the actual area of a zone instead of plan area. The chart can be used for vertical surfaces by modifying the formula for ΣI. For example, if the vertical surface is normal to the reference direction in azimuth (0 deg. Az) $E = \frac{\Sigma I}{H^2} \mathrm{Cos}^2\,\theta.\,\mathrm{Sin}\,\theta.\,\mathrm{Cos}\,\phi$ where ϕ is the azimuthal direction of the point concerned.

Other uses of the chart

There is an advantage in tilting fluorescent lanterns, for wide roads, up to an angle of 25 deg. to the horizontal. If an isocandle diagram is required for this angle of tilt when the lantern has been photometered horizontally it is readily obtained by using the spherical chart; conversion is very laborious without it.

Conclusions

The method has been proved practicable and useful in planning installations. Such a chart is a worthwhile investment when many floodlighting schemes are to be planned. Experience indicates that a 2 ft. diameter spherical shell is convenient for use. Opal "Perspex" or rigid PVC provides a surface convenient for marking by pencil. The charts in use have been lacquered with a polyester resin after waxing the engraved lines; this takes pencil well and can be cleaned off with a detergent.

Acknowledgment

The author acknowledges assistance from colleagues in the BTH Research Laboratory in making up the equipment and in the preparation of this article.

Lighting Abstracts

OPTICS AND PHOTOMETRY

535.34

458. Photoelectric apparatus for measuring the transparency of the atmosphere.

O. I. POPOV, *Svetotechnika*, **3**, 20-22 (*Jan.*, 1957). *In Russian.*

The transmission of a long column of air is measured photoelectrically by a null method. A collimated beam of light is sent to a distant mirror and on return, after attenuation in the atmosphere, is focused on to the photoelectric receptor. A comparison beam from the same source reaches the receptor through a very short path, and the attenuation necessary to match the test beam is a measure of the atmospheric attenuation. Results are given comparing the readings of the instrument with a nephelometer. R. G. H.

LAMPS AND FITTINGS

621.329

459. A new translucent diffusing material.

V. I. DOLGOPOV and N. G. PETROVA, *Svetotechnika*, **3**, 13-16 (*Jan.*, 1957). *In Russian.*

A diffusing material is described which consists of woven glass fibre integrated into a polymethyl methacrylate base. Advantages over glass diffusers include lower specific weight, high impact strength and ease of mechanical working. Full details of the diffusing characteristics of different weaves of the glass fibre material are given, both for the weave alone and when integrated into the methacrylate base. R. G. H.

621.327.9

460. The coefficient of utilisation of tubular flash discharge lamps.

I. S. MARSHAK, *Svetotechnika*, **3**, 17-20 (*Jan.*, 1957). *In Russian.*

Experimental results are given of the effect on the light output and light-time characteristics of flash discharge lamps, of various parameters such as diameter of tube, gas pressure, etc. R. G. H.

621.327.534.2

461. High pressure mercury vapour lamps with colour correction.

G. I. RAGULIN, *Svetotechnika*, **3**, 1-4 (*Feb.*, 1957). *In Russian.*

The characteristics of a series of H.P.M.V. lamps with pear-shaped fluorescent envelopes, from 250-1,000 watts, are described. Dimensions, spectral emission, flux distribution and operating circuits are given. R. G. H.

621.329

462. Discoloration of polystyrene shields: its cause and solution.

J. B. ORR, *Illum. Engng.*, **52**, 133-136 (*Mar.*, 1957).

Discoloration (yellowing) of polystyrene used in the construction of fluorescent luminaires is found to be due to ultra-violet radiation in the waveband 3,000-3,900 Å. Spectro-photometric tests on typical fluorescent lamps confirm the emission of energy in this waveband. Materials have been developed for inclusion in the polystyrene which absorb the ultra-violet radiation and thus retard the discoloration. Since the discoloration of polystyrene is confined to the surface layer nearest to the source, it is an economic advantage to combine the absorbing materials only with this particular layer. P. P.

LIGHTING

628.972

463. Lighting in a conference room.

Ljuskultur, **29**, 27-28 (*Jan.-Mar.*, 1957). *In Swedish.*

Examples of conference room lighting are described with photographs, including a Swedish and two German examples. The Swedish room has indirect lighting off the ceiling, from banks of fluorescent lamps, supplemented by direct filament lighting to offset the soporific character associated with totally indirect lighting. R. G. H.

628.93

464. Regulations for the implementation of lighting installations.

M. S. RYABOV, *Svetotechnika*, **3**, 9-13 (*Jan.*, 1957). *In Russian.*

Inconsistencies and contradictions in the older regulations for electrical installations in buildings demanded a revision and co-ordination in the illuminating engineering and electrical sections of the building regulations. The article summarises these revisions. R. G. H.

628.972

465. New lighting for Stockholm Electricity Authority.

E. BEVERUD, *Ljuskultur*, **29**, 3-4 (*Jan.-Mar.*, 1957). *In Swedish.*

The public hall of the Stockholm Electricity Authority has been provided with banks of fluorescent lamps along the main beams, to blend with and enhance the architectural features of the hall. The business counters have over 100 lm/ft² and the greatest care has been taken to avoid glare. The general offices have also been provided with continuous banks of lamps in diffusing envelopes, some banks being placed over the windows, where they give an illumination of over 40 lm/ft², the inner banks in the room giving 30 lm/ft². The greater part of the installation is lamped with 40-watt lamps. R. G. H.

628.971

466. Lighting for the construction of the hydroelectric power station at Kuibishev.

M. V. SOKOLEV, *Svetotechnika*, **3**, 3-8 (*Jan.*, 1957). *In Russian.*

The special problems involved in the lighting of large open spaces where constructional work is going on include that of atmospheric dust, which reduces contrast, and the difficulty of getting an electricity supply to the light sources during the changing demands of the siting of the work. Enough light must be provided to enable the rapid movements of complex mechanical equipment (cranes, excavators, etc.) to be seen and anticipated. Experimental studies of illumination, brightness and visibility factors were first undertaken, and the results applied to the design and siting of projector towers each 50 metres high, disposed around the site of the Kuibishev power station. Banks of projectors, lamped with silvered projector lamps from 1 to 5 kw. were employed, giving a power distribution of 1.25 watts per sq. metre of the site. Details of the design and layout of the projector towers are given. R. G. H.

628.97

467. Lighting in Museums: Light and colour in the presentation of objects.

M. DERIBERE, *Bull. Soc. Franç. Elect.* 7th Series, **7**, 122 (*Feb.*, 1957). *In French.*

Effects of fading and deterioration due to irradiation are briefly discussed: recent tests have shown that the

deleterious effects of all available light sources are small and probably less than daylight; deterioration also occurs with objects which have been packed with all light excluded. There is some advantage in the use of artificial light sources which can be switched off when galleries are not open to the public. The effects of colour of the light and of the backgrounds to objects exhibited are important. A reddish light is not, as might be thought, suitable for emphasising reds in painting, for it floods the field of view with a reddish colour to which the eye adapts, so that reds in the picture appear degraded. Neutral backgrounds and white light are in general to be preferred. Some objects, however, are better shown with a slightly tinted background, and recommendations are given.

Sculpture, friezes and bas-reliefs can be lighted by projectors, in some instances with masks which produce a beam exactly fitting the statue. Some statues are displayed in this way with a dark background. Showcases can be lighted with advantage with light of the colour best suited to the exhibits, which may contrast with that of the general lighting. J. M. W.

628.92

468. Development of methods for the calculation of natural illumination in buildings taking into account reflected light.

R. KITTLER, *Svetotechnika*, **2**, 18-21 (*Mar.*, 1956). *In Russian.*

Reference is first made to methods for the determination of direct daylight developed by Daniluk ("Building press," Moscow—Lenigrad 1941 is given as a reference), and thence, from the concept of the CIE International Sky Brightness Distribution, correction coefficients to convert Daniluk's values to Sky Components are given. A nomogram, based on work by Hannauer, Pleijel and the author himself, enables the indirect component of daylight in a room to be determined both for points where direct skylight is obstructed and where it is unobstructed. R. G. H.

628.971.6

469. A new approach to highway tunnel lighting.

J. R. BRASS, H. SKOOTSKY and G. A. TROSPER, *Illum. Engng.*, **52**, 137-143 (*Mar.*, 1957).

From a study of San Francisco's numerous vehicular tunnels the authors have propounded a number of principles for the lighting of such tunnels. Wall and ceiling luminances are of greater importance than roadway illumination levels. Luminaires are most effectively disposed when in continuous lines. Tunnel lighting for daytime entry should cater for a rapid (2 seconds) rather than a slow (10-20 seconds) adaptation time, based on vehicle speeds of 50 m.p.h. This means increased luminance levels in the first 200-300 yards of tunnel. Sunlit haze from dust and exhaust fumes produces a veiling brightness outside a tunnel entrance which adversely affects visibility. P. P.

628.971.6

470. Some factors influencing the night visibility of roadway obstacles.

D. M. FINCH, *Illum. Engng.*, **52**, 120-129 (*Mar.*, 1957).

Summarises work carried out at the University of California on street lighting and its evaluation in terms of visibility. The operation of the author's visibility meter is described, as also is its calibration in terms of luminance, contrast threshold and Visibility Index. Results of measurements in test installations producing uniform and non-uniform pavement illuminations are reported. These include an evaluation of three types of targets proposed for roadway visibility measurements. P.P.

628.971.6

471. A highway lighting test installation.

G. A. NAGEL, *Illum. Engng.*, **52**, 155-165 (*Mar.*, 1957).

In connection with the lighting of the new Connecticut Turnpike, full-scale tests have been made of three types of luminaire (fluorescent, mercury and mercury in elongated reflectors) on lengths of the completed road. The tests comprised appraisals by lighting engineers and road users, combined with extensive photometric comparisons. The lighting engineers preferred the mercury lighting, while the road users preferred the fluorescent lighting. It was found that the photometric comparisons of luminaire and pavement luminances, disability veiling brightness and illumination levels were not the sole criteria for good roadway lighting. P.P.

628.971

472. American standard practice for protective lighting.

Illum. Engng., **52**, 174-188 (*Mar.*, 1957).

Prepared by a Sectional Committee of the American Standards Association, this Standard Practice deals with all aspects of outdoor lighting for the protection of industrial premises from theft and sabotage. The principles of good protective lighting are listed, including the provision of adequate light on the premises' boundaries with glaring light in the eyes of the trespasser, high luminance contrasts between the trespasser and his background and no light on the guards. Lighting specifications to conform with these principles in varied circumstances are given and the types of lamp, lighting equipment and electrical distribution to achieve these specifications are dealt with. P.P.

628.971.7

473. Seven articles on lighting for sports.

Lichttechnik, **9**, 105-117 (*Mar.*, 1957). *In German.*

(1) New Leipzig stadium by floodlight, by H. ROSSLER, pp. 105-107.
(2) Lighting of football fields, by G. GEHM, pp. 107-109.
(3) New method of lighting a stadium, by W. RIEMENSCHNEIDER, pp. 110-111.
(4) Floodlighting for football arenas, by W. J. P. WERNZ, pp. 111-114.
(5) Mobile lighting for arena displays, by W. KAISER, pp. 114-115.
(6) Lighting of the indoor sports hall of the Cologne tennis and hockey club's Rot-Weiss stadium, by P. H. LANE, p. 115.
(7) Floodlighting installations for the stadia at Vienna and at Belenses, near Lisbon, by F. BUSCH, pp. 116-117.

The contents of these short articles are generally indicated by their respective titles. In (1) there is a description of the four 55-ft. lattice masts mounted at the periphery of the seating and inclined inwards at 30 deg. Each carries 15 projectors of 5 kw. each at a height of 130 ft. above ground level. The average horizontal illumination is 8 lm/ft^2. Article (2) is a review of football-ground lighting with a short description of an installation at Dortmund. Some trials made at Lucerne are described in (3), while (4), which deals mainly with principles, includes also some illustrative examples. A different problem, viz., that of lighting a large area temporarily for an arena display or something similar, is dealt with in (5). The lights were mounted on 60-ft. towers constructed of steel scaffolding and gave a vertical illumination of 10 to 24 lm/ft^2. Article (6) is a short description of an indoor installation in a windowless building used for tennis, hockey, etc., while (7) describes the more or less orthodox lighting of the stadia at Vienna and Lisbon. J. W. T. W.

HOME LIGHTING

An investigation in six parts by Derek Phillips, M.Arch. (M.I.T.), M.C.D., B.Arch. (L'pool), A.R.I.B.A.*, into the relationship between architecture and lighting in the modern home.

PART 4 - - - - - - Kitchen and Dining Room

The lighting of the kitchen should emphasise the air of cleanliness and efficiency which is the mark of the modern approach to this, perhaps the most important, room of the home. Hence the kitchen is the one room for which fluorescent lighting has become accepted, though as the modern kitchen is not as "cold" as the ideal of the 1930s (there being a greater use of colour—for refrigerators, floor surfaces, and cupboards) de luxe warm white or colour-matching lamps are to be preferred. (The latter should be supplemented by tungsten lamps.)

The IES recommendation is 10 lm/ft², yet a British Standard Code of Practice suggests that for kitchens up to 80 sq. ft. in area 100 watts of tungsten lighting is sufficient, though a 100-watt lamp in an opal glass sphere gives only about 4 lm/ft². An 80-watt de luxe warm white fluorescent lamp, on the other hand, will, in a kitchen of this size, provide 10 lm/ft² and, whereas a tungsten lamp, being a compact source, tends to produce unwanted shadows, the linear nature of the fluorescent lamp reduces shadows.

The frequency with which accidents occur in the kitchen suggests that a high level of illumination should be provided above the cooker, the sink, and the table used for food preparation; in the larder or pantry; and wherever ironing takes place or a washing machine is used. Surface-mounted or recessed lighting fittings should be provided at these points and in such a way as to eliminate shadows on the work.

Seen on the right is a kitchen lit as follows:—

General lighting.—Built-in above sink unit, one 5 ft. fluorescent lamp, with glass or plastic diffuser.

Local lighting.—Built in above cooker, one 2 ft. fluorescent lamp, concealed behind canopy from which air is exhausted. Fittings fixed below suspended cupboards, with three 3 ft. fluorescent lamps covered by plastic or opal glass sheeting. Ceiling-mounted fitting in larder—a 60-watt tungsten lamp with an opal glass shade.

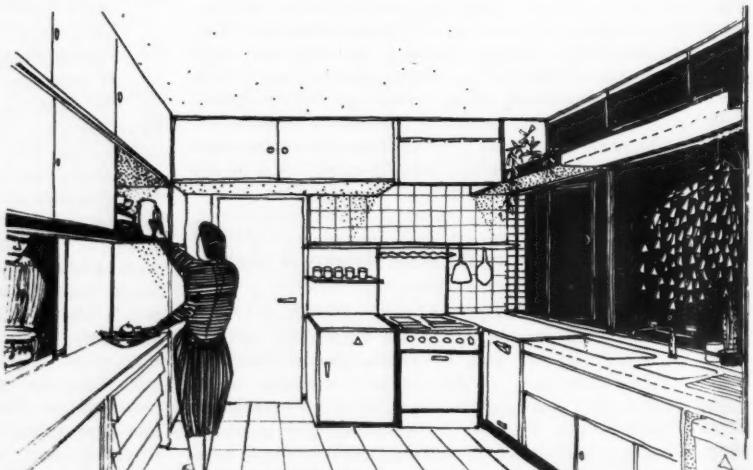
The total wattage of this scheme would be less than 300, and the illumination levels would satisfy the IES Code at all points where work is done.

The lighting equipment should be designed for easy maintenance, as, particularly with gas cooking, a deposit of grease will form on the diffusing covers, which should, therefore, be readily removable for cleaning. The unit lighting the cooker would require a soffit of clear plastic or glass, which could be wiped periodically, while the fascia, as well as acting as a cut-off to prevent glare, would serve as a cowl for fume extraction. Depending on the layout of the kitchen, further local lighting might be required at other points—e.g., inside cupboards for crockery or glassware (in the example illustrated this would be provided by the general illumination), or inside low-level cupboards, such as those below the sink unit. The insides of refrigerators are now usually provided with built-in lighting.

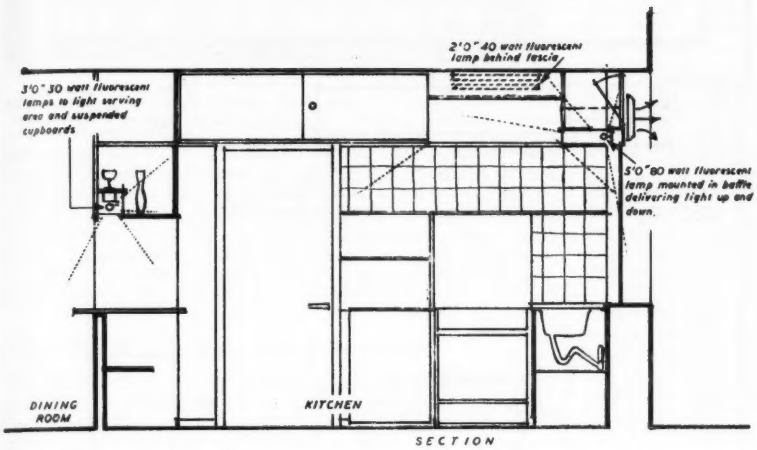
As reflectance factors in kitchens are usually high, an effective lighting scheme might be provided by fluorescent lamps concealed by an opaque suspended ceiling and shining on to the walls, adjacent to which the light is, in fact, required. Inter-reflection would ensure that the suspended ceiling did not appear too dark.

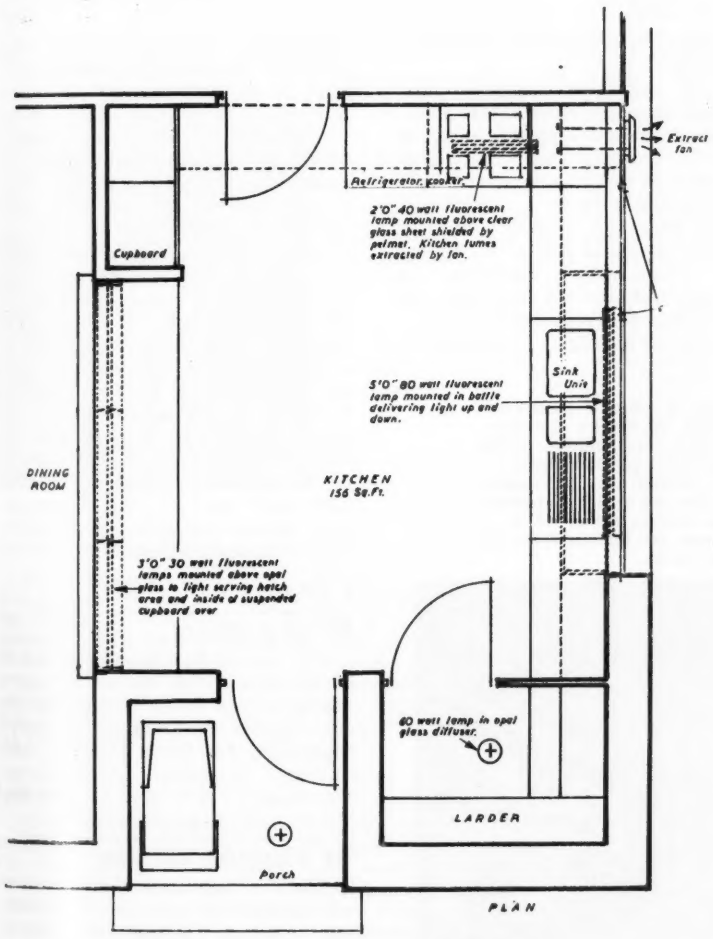
The American IES Code recommends 40 lm/ft.² for lighting the more important areas of the kitchen, and a recent American publication sponsored by a well-known lamp company recommends double this. This figure may seem excessively high, but luminous ceilings have been installed in some American kitchens giving illumination levels of between 50 and 100 lm/ft.²

Where a room has to serve two purposes, its design is inevitably a compromise, but carefully designed lighting can help to separate the two areas or separate the area in use at any one time. The dining-room as part of the living area was dealt with in the third article of this series, but



*Consultant architect to the A.E.I. Lamp and Lighting Co., Ltd.


2'0" 40 watt fluorescent lamp behind fascia
3'0" 30 watt fluorescent lamps to light serving area and suspended cupboards
5'0" 80 watt fluorescent lamp mounted in baffle delivering light up and down.
DINING ROOM
KITCHEN
SECTION


Extract fan
Refrigerator, cooker
2'0" 40 watt fluorescent lamp mounted above clear glass sheet shielded by pelmet. Kitchen fumes extracted by fan.
Cupboard
Sink Unit
5'0" 80 watt fluorescent lamp mounted in baffle delivering light up and down.
DINING ROOM
KITCHEN
156 Sq.Ft.
3'0" 30 watt fluorescent lamps mounted above opal glass to light serving hatch area and inside of suspended cupboard over
60 watt lamp in opal glass diffuser.
LARDER
Porch
PLAN

Above, plan and section of lighting scheme for an imaginary kitchen designed by the author. Left, perspective sketch of same kitchen. Local lighting is provided over the cooker and over the counter which separates the kitchen from the adjacent dining room. General lighting comes from a fluorescent lamp over the sink unit.

we must now deal with the dining-room as a part of the kitchen.

Good kitchen lighting, being of high intensity and shadowless, is most unsuitable for the dining area. Additional treatment is, therefore, required, and this might well take the form of a tungsten pendant fitting over the dining table. As the table may serve also as a kitchen table, or may, when not in use, be folded away, the suspension should be flexible so that the fitting can be raised out of the way when not required. This fitting should be controlled separately from the general kitchen lighting, so that the latter can be switched off when meals are eaten to reduce the view of empty pots and pans and dirty dishes to a minimum.

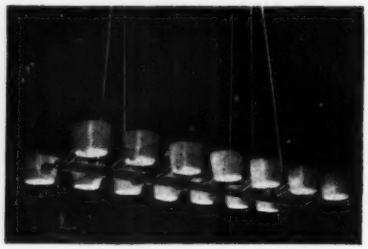
When the kitchen is large enough, it is usually possible to separate the eating and cooking areas by an architectural feature, such as a screen, or by planning a dining alcove. When this is done it is necessary to provide local lighting for the sink and the cooker so that these items can be used in safety without recourse to the general lighting.

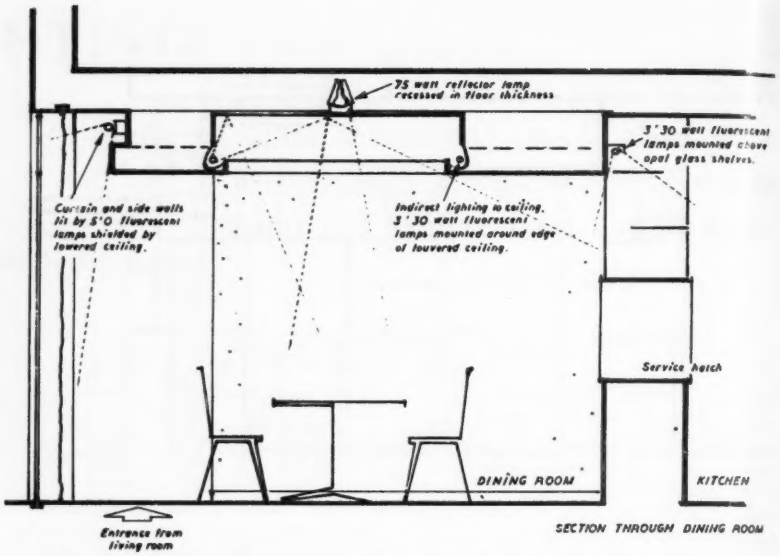
THE DINING ROOM

The family dining-room has become less popular for a variety of reasons—principally because modern space standards do not permit architects to devote so much space to a room used only periodically and because the age of the "common man" has seen the end of cheap domestic labour. However, when a formal dining-room is provided the lighting requirements are similar to those of the restaurant: the task is the same and the light is needed in the same places—on the table and on the faces of the diners. The dining-room is essentially a room where a formal meal can be eaten—where fine crockery, cutlery and glass can be seen to the best advantage, and where conversation may be enjoyed and the slightest inflexion of mood or gesture observed. The IES Code recommends an illumination level of 7 lm/ft^2.

The crystal chandelier of the eighteenth-century dining-room, related as it was to the decorative style of the period, was a rich and exciting solution to the problem of its day; it gave a "sparkling" light on to cut glass and silver and, because it was generally quite large, with numerous candle flames, it did not appear too glaring. Some people think that the candle is still the best light source for the dining-room, with its low ceiling levels, and its plain wall surfaces, but when candles on the table are used

Right, lighting scheme for dining room, designed by the author. The table is lit by downlights recessed into the ceiling, which is itself lit by fluorescent lamps concealed by a cove around the periphery of the room. Below, multi-light fitting suitable for use over a dining table (Heal and Son, Ltd.).




75 watt reflector lamp recessed in floor thickness
3'30 watt fluorescent lamps mounted above opal glass shelves.
Curtain and side walls lit by 5'0 fluorescent lamps shielded by lowered ceiling.
Indirect lighting in ceiling. 3'30 watt fluorescent lamps mounted around edge of louvered ceiling.
Service hatch
DINING ROOM
KITCHEN
Entrance from living room
SECTION THROUGH DINING ROOM

alone the results are often disappointing—it is almost impossible to see to eat, or to carve, and heavy shadows are cast on people's features. The solution lies in satisfying the two fundamental needs mentioned above:—

Downlighting. For this, a tungsten source is best, and there is an advantage in using several small sources, rather than one large one.

Horizontal lighting. This can be achieved equally well by a linear source, or by diffused or indirect light.

In a small dining-room a single pendant fitting, as illustrated in the previous article, may be sufficient, as this performs both the above functions successfully. Alternatively many other types of fitting, with, for example, plastic or cane shades, may be used. Where the room is large a multiple-light fitting can emphasise the shape of the table.

It is sometimes suggested that tungsten spotlights recessed into a ceiling above the table provide sufficient light for a dining area. Spotlights, however, do not give horizontal light, and cannot provide a satisfactory scheme alone. A solution is to lower all but the central part of the ceiling, into which the spotlights are recessed, and light this area indirectly by fluorescent lamps concealed by a cove around the edge. The brightly lit central area will emphasise the table and give adequate horizontal light, while the spotlights will give the necessary extra downward light. Many variations of this theme are possible, which the architect can arrange according to the ceiling level, the nature of the structure, the materials used, and the requirements of his client.

It is a mistake to light a dining-room evenly, as the aim should be to make the table appear bright in contrast to the rest of the room. However, if the room is large, it is necessary to supplement a fitting over the table in some way. Such additional light is best provided by wall fittings, by pelmet lighting of the curtains, by built-in lighting to wall cupboards or similar methods. Controls are available which can dim this lighting to give greater emphasis to the table when the meal commences.

Kitchen in house at Blackheath designed by Patrick Gwynne, L.R.I.B.A. In addition to the fitting over the table, there is local lighting over the cooker, over the sink and incorporated in the storage fitting which separates the kitchen from the dining room.

COMMENT

By an architect

It is curious how the disappearance of domestic service has led to such a raising of standards in the kitchen. Mr. Phillips makes some attractive suggestions for its development, and lighting is obviously a key to success. One wonders if it may not one day attract back domestic assistance.

By a lighting engineer

Surely a high level of illumination everywhere not only at the cooker, etc. Special fittings at special positions will create shadows, not eliminate them. I feed in my dining room every day: I'd soon tire of Mr. Phillip's lighting scheme—I think he has taken his restaurant analogy too far.

NEW PRODUCTS

Tungsten lamp industrial luminaire

Upward illumination is incorporated in most fluorescent installations and F. W. Thorpe Ltd. have now adapted their popular overlamp dispersive reflectors for tungsten lamps to incorporate this feature in their new "Toplite" reflector. Apertures in the top of the reflector direct a proportion of the light output on to the ceiling, thus overcoming the "dark tunnel" effect which is usual with the normal type of dispersive reflector. When erected at the recommended height the apertures in the reflector are invisible.

Architectural tungsten lamp luminaire

Holophane Ltd. are marketing a new luminaire designed for architectural lighting. It is a wall-mounting crystal glass reflector designed to give a semi-indirect lighting distribution and is suitable for applications in banks, offices, important corridors, foyers, etc. The prismatic reflector with pleasing fluted appearance measures 10 in. at the mouth and the fitting is supplied with BC lampholder for 100-150-watt GLS lamp. The glass is held in an anodised aluminium alloy cup mounted on a white enamelled bracket, the complete ensemble being of contemporary style.

Holophane architectural luminaire

Battery-operated fluorescent unit

Barber Electrical Services Ltd. announce a restyled version of their low-voltage battery-operated fluorescent lighting equipment. The system comprises a power unit which operates from a 12-volt car battery and gives an output of 60 watts from which up to four 15-watt standard fluorescent lamps can be run. The system has applications in vehicles and other places where good lighting is required but where only a battery supply is available. A complete unit, including two 15-watt lamps, costs £18.

Louvres

J. Rivlin, Ltd., announce a new louvre system for fitting to recessed open type shop window reflectors. Known as the "Rivlite," the unit consists of a series of concentric circles arranged to fit neatly and inconspicuously into the opening of the recessed reflector, thus cutting out spilled light and achieving an appearance comparable with that of modern type louvred reflector units.

Control gear

New economical control gear for twin-lamp luminaires is now being marketed by the General Electric Co., Ltd. This development follows the recent introduction of the GEC switchless start circuit and control gear for single fluorescent lamps, which provides, at a lower price, control gear with a power factor as high as that previously attained only by the use of the GEC twin-lamp circuit. The new control gear costs no more than two sets of switchless start gear, yet it provides the anti-stroboscopic feature of the well-known twin-lamp circuit. The circuit employed includes a single filament heating transformer with three secondary windings providing pre-heating current for both lamps. This transformer is incorporated in one bitumen-filled pressed steel container with a special choke for the capacitive circuit. The inductively operated lamp is fed through a separate choke of the familiar brick type. The capacitor—a 6.85 mfd. Aroclor series type—is the same as that used with the twin-lamp switch-start circuit. The new circuit operates as follows: On closing the supply switch, mains voltage is applied to the transformer primary and across both lamps. Within about one second the cathodes are brought up to emission temperature and the lamps light up. Earthed striped lamps are necessary to ensure starting under all conditions, and radio interference suppression capacitors are connected across each lamp.

"Floating" fluorescent fixture

A new ceiling-size "floating" fixture, the "Strato-Lux," introduced by Curtis Lighting, of Chicago, is a large area luminaire supplied as a complete unit to the electrical contractor. The entire luminaire is suspended from a lighting grid which is attached to the ceiling. As there is no juncture between the fixture and the side walls, the fixture seems to float, creating a sense of light airiness. The fixture, which is actually a packaged lighting system, consists of two parts: a ceiling-installed fluorescent grid system, and a suspended T-hanger aluminium framework, which holds the vinyl plastic louvre-diffuser panels. These 2 ft. × 2 ft. panels are the company's new "CurtiCell" louvre-diffusers which provide 25-degree crosswise and lengthwise shielding. They act both as a louvre to prevent direct glare, and as a diffuser to soften the light and minimise reflected glare. Two pieces of self-extinguishing vinyl plastic are used to form each "CurtiCell" panel: a flat top sheet bonded to a vacuum-formed cellular bottom sheet. The complete panel weighs one pound, and can be easily lifted from the framework for cleaning in a mild detergent. The grid system consists of a quickly-hung section of channels to hold the fluorescent lamps on either 12-in. or 24-in. centres. The suspended aluminium framework hangs 21 in. below the channels and is an integral part of the system.

"Strato-Lux" lighting systems can be provided in sizes to fit any 8 ft. × 8 ft. or larger room.

Personal

Ascot Lamps and Lighting Ltd. (formerly Tungstalite Ltd.) announce the following appointments: MR. Z. DESHAW, formerly Managing Director of Ismay Lamps Ltd., has been elected to the Board and appointed Managing Director; MR. R. R. COVENTRY has joined the Company as Assistant Sales Manager and MR. A. A. TUCKER has been appointed Purchasing Officer and Transport Manager.

The "Atlas" Lighting Division of Thorn Electrical Industries Ltd. announces the appointment of MR. H. FOSTER as Area Sales Supervisor, South Western Area. Mr. Foster, who was formerly with AEI Lamp and Lighting Co. Ltd., joined BTH in 1935 to represent them in Birmingham and Leicester. In 1936 he was appointed Manager, Lamp and Lighting Sales, Sheffield Office, and in 1940 was transferred in a similar capacity to Bristol and the South West.

Ekco-Ensign Electric Ltd. announce the recent appointment of MR. H. V. RICHARDS as their representative covering part of the Middlesex area and some Western postal districts; also MR. P. MURRELL who will cover the West End of London area.

MR. W. J. WALPOLE, London Manager of Lumenated Ceilings Ltd., has recently been appointed General Manager of the Company.

Book Review

"We Live by the Sun," by J. Gordon Cook, published by G. G. Harrap and Co., Ltd. Pp. 183 + ix, with 13 half-tone illustrations. Price 12s. 6d.

This is a book on light "for the man in the street—and his wife—who want to keep in touch with scientific progress in this bewildering modern world." The author has the remarkable gift of combining vivid description with scientific accuracy and this book, which forms one of a series called "Science for Everyman," covers a very wide range of phenomena associated with the production or use of light. For instance, one chapter deals with the way in which the sun is thought to maintain its immense output of energy, while in another there is a description of the way in which bees, ants and other insects use the polarization of skylight for direction-finding purposes. Chapter headings such as "Light made by man" and "The wonder of vision" show that the illuminating engineer's immediate interests are not neglected and there is a fascinating account of the ways in which the sun's energy may be used directly to provide future generations with power.

To every lighting engineer who fancies that he knows everything worth knowing about light, I would say, "Beg or borrow this book, or acquire it by other means such as purchase, and you will have an eye-opening experience well worth the effort or the cost." He will have, too, some delightful hours in company with a guide who, to judge by the sections dealing with familiar matters, is as reliable as he is entertaining.

J. W. T. W.

Correspondence

Rules for Television Viewing

Dear Sir,—In the interests of accuracy I wish to comment on your May editorial remarks on the subject of ideal conditions for television viewing.

I am sure that Mr. H. C. Weston would be the first to disclaim any originality for the advice given to viewers in connection with the special display recently at the Design Centre. The first publication on this subject in this country was in the Summer, 1949, issue of "*Vision*—the popular magazine about the Eyes," published by the Association of Optical Practitioners where the editor gave "Seven Simple Rules for Television Viewing."

Articles on the same subject were published in most of the issues of *Vision* between 1949 and 1955. Moreover a special reprint in leaflet form was prepared and tens of thousands of copies of this leaflet have been distributed to the public. In 1952 Mr. J. L. H. Moss devoted a considerable part of his Ettles Memorial Lecture at Bournemouth to this subject. Talks on the subject have also been given in "Woman's Hour," so your comment that no one has ever done anything about this important subject before now was rather exaggerated.

London. SAM BLACK.

Trade Literature

H. W. FIELD AND SON LTD., Harold Wood, Essex.—Illustrated pocket-size catalogue of fluorescent equipment giving full details of a comprehensive range of lighting fittings and control gear for industrial and commercial fittings.

HEYES AND CO. LTD., Water Heyes Electrical Works, Wigan.—Leaflet No. LF.9 giving details and prices of prismatic and lacent fittings for industrial use.

KAYDELL LIGHT FITTINGS, Crowhurst Road, Hollingbury, Brighton 6.—Brochure illustrating a new range of contemporary multi-lamp fittings constructed from natural woods combined with polished and lacquered brass for domestic use.

LAW AND PLUMTREE, 6, Lansdowne Road, Erdington, Birmingham, 24.—Descriptive brochure of a new range of "Brite-Lite" plug-in fluorescent lighting fittings including prices.

Physical Society Colour Group

AGM and 100th science meeting

At the Annual General Meeting of the Group, held at the Royal Photographic Society's house on April 3, Mr. J. W. Perry (of Hilger and Watts, Ltd.) was elected Chairman in succession to Mr. R. G. Horner who, as is customary with the Group, gave his Chairman's Address at the science meeting held immediately afterwards.

He took as his subject "Colour systems and CIE transformations," confining the first part of his paper to a comparison of the various methods currently used for giving a precise description of a surface colour, i.e., the colour of an object as distinct from the colour of a light. After discussing the bases upon which colour systems of this kind could be constructed, Mr. Horner described the well-known Munsell colour atlas in which a large number of colour samples are arranged systematically according to hue, depth of colour and lightness. This, and the analogous Hesselgren system could be described as "colour appearance" systems. Then came reference to the "colour mixture" systems of Ostwald and Ridgway, and colorant mixture systems such as the "Colorizer" range of pigments. The Lovibond "Tintometer" might, perhaps, be included in that class, while the German DIN system was partly an appearance and partly a mixture system.

In the final section of his address, Mr. Horner dealt with the mathematical problems involved in relating the CIE colour system to a system in which equal lengths of line, or equal numerical differences, would represent equal differences in appearance, at least approximately.

The following meeting, held at Imperial College on May 1, was the hundredth science meeting of the Group and to mark the occasion Professor W. D. Wright gave a brief résumé of the Group's origin and history. He paid a special tribute to *Light and Lighting* which, he said, had consistently reported the proceedings of the Group from its inception and he showed a volume containing the cuttings taken from the various issues of the journal.

Three papers were then read by students in the Technical Optics section of Imperial College. The first was by Mr. M. Gadsden and dealt with "Colorimetry and colour photography as applied to natural phenomena." Owing to the trivariance of colour vision, a colorimetric measurement will give complete information about the composition of a light if this does not depend on more than three variables. This principle Mr. Gadsden had applied visually to the colour of the zenith twilight sky, and photographically to the aurora borealis.

In the second paper, entitled "Properties of extra-foveal vision," Mr. F. J. J. Clarke described experiments on local adaptation at the periphery of a dark-adapted retina under conditions of steady fixation. After a few seconds a rapid reduction of subjective brightness was always observed, and the nature and origin of this effect were discussed, first by Mr. Clarke in his paper and then by members of the audience.

The final paper, by Mr. K. J. McCree, described the "Effects of steady fixation on colour matching." It is well known that if an observer trying to make a match in a colorimeter keeps his gaze fixed, his colour discrimination deteriorates and the author said that with two halves of the test field equated in brightness, some observers found that they lost all colour discrimination within a few seconds; others could match green and blue but discriminated these from red; others again found practically no deterioration, even after several minutes of fixation.

The Summer Visit of the Group took place on June 19, when members were entertained at the Research Laboratories of the General Electric Company, Ltd., at Wembley.

Situations

Vacant

Philips Electrical Limited. A vacancy exists in the Lighting Division of this Company for a COMMERCIAL ASSISTANT. Applicants should be between 28/35 years of age with some experience of commercial correspondence preferably dealing with lighting fittings and accessory manufacturers. A mechanical or electrical engineering qualification and/or experience is desirable. The appointment is in London and the salary will be based upon qualifications and experience. Please reply giving brief details in confidence to the Personnel Officer, Century House, Shaftesbury Avenue, W.C.2, quoting ref.: 112.

Ekco-Ensign Electric Ltd., 45, Essex Street, W.C.2, require (a) Young LIGHTING ENGINEER for IE Dept., London; (b) LIGHTING ENGINEER to contact architects and consultants; (c) ELECTRIC LIGHTING FITTINGS DESIGNER. Apply Senior Lighting Engineer.

ELECTRICAL ENGINEER with B.Sc., aged 28-35 for Technical Commercial activities in the field of lamp applications, illuminations, etc., is required by N.V. Philips Gloeilampenfabrieken, Eindhoven, Holland, for a progressive post in an English-speaking country overseas, probably in Australia or New Zealand. Specialised knowledge in this field is desirable though not essential. There will be a period of training of 1½-2 years in Eindhoven before posting. The salary will be commensurate with age, experience and qualifications. The conditions of employment include periodic leave in England. Candidates should apply in the first instance to Employment Officer, Central Personnel Department, Philips Electrical Ltd., Lindsay House, Shaftesbury Avenue, London, W.C.2.

JOSEPH LUCAS (ELECTRICAL) LTD.
GREAT KING STREET,
BIRMINGHAM.

As a result of expansion of our road vehicle lighting development department to meet the growing demands of the motor industry we have vacancies for

ENGINEERS AND PHYSICISTS

of at least H.N.C. standard to work on the following projects. Experience or knowledge of photometric and electrical instruments desirable.

The design and development of vehicle lighting equipment and in particular the development of optical systems for future projects.
Development work on specific problems related to vehicle lighting equipment and the design of laboratory and factory control equipment for these products.

In addition there are vacancies for senior designers required to work in close co-operation with car designers and styling engineers on the design of lighting equipment for new car models. Experience in the design of pressed metal components for large quantity production desirable.

All of these positions carry attractive starting salaries and provide excellent prospects for advancement. Staff Pension Fund.

Apply in writing, stating age, qualifications and experience, to the Personnel Manager, Joseph Lucas (Electrical) Limited, Great King Street, Birmingham 19, quoting reference PM/D/156.

Miscellany

British Standard

Amateur photographers and photographic dealers frequently find it difficult to determine the type of flash bulb to be used with a given camera shutter. Aware of the disappointment which can arise when the incorrect selection of flash bulbs leads to faulty exposures, the British Photographic Manufacturers Association requested the preparation of this British Standard.

The standard specifies four classes of expendable flash bulbs according to the time taken to reach " peak " or " half-peak " light output after closure of the firing contacts. The classes are: F (fast); M (medium); S (slow); FP (focal plane).

The standard includes typical characteristic curves which show the variation of light output with time for each class.

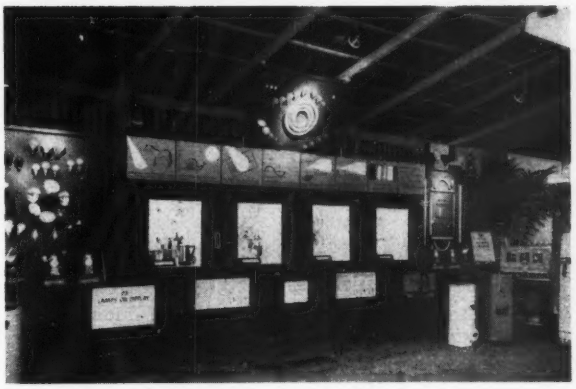
This classification is now being used for the purposes of specifying the delay times to be provided by camera shutter synchro-flash mechanisms in a revision of B.S. 1592 " Camera shutters," which is being prepared. Copies of B.S. 2833 : 1957 may be obtained from the Sales Branch, British Standards Institution, 2, Park Street, London, W.1. Price 2s. 6d.

Catalogues required

The Librarian at the College of Technology, Gosta Green, Birmingham, 4, would be pleased to receive catalogues from manufacturers of lighting equipment.

Lighting display in Bermuda

At a recent agricultural exhibition in Bermuda the Bermuda Electric Light Co. Ltd. arranged a special display of lighting which attracted considerable attention. The object was to promote domestic lighting and the uses of many different types of lamp were shown.



Capital available

£5,000 Capital or more available for Finance. Venture's Estab. Business's. Stocks, etc. Any scheme considered. Write strict confidence, to Box 935.

Course in lighting

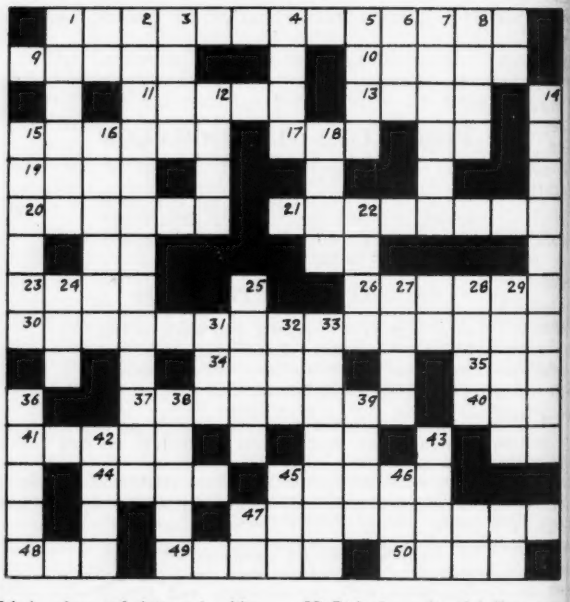
It is understood that there are still vacancies in the course on lighting to be held at the York Institute of Architectural Study for September 12-16. The course will be arranged as a seminar in which each session will be opened by a particular speaker the other lecturers being present throughout the course to ensure a balanced discussion of each topic. Lecturers will be W. A. Allen, C. Dykes Brown, H. L. Gloag, Dr. R. G. Hopkinson, D. L. Medd, D. R. H. Phillips, and A. Wilcock. Full details of the course (the tuition fee for which is four guineas) can be obtained from the York Institute of Architectural Studies, Micklegate, York.

POSTSCRIPT By "Lumeritas"

WE are so deeply concerned with light as the agent of sight that we are much inclined to ignore other human effects of light. Certain biological cycles in birds and animals are known to be affected by light, and so also is plant growth, but not enough is known about the non-visual effects of light on man. So, it is interesting to note that a physiological investigation into the biological effects of light on man is being undertaken this summer; during an expedition to Spitzbergen, in which members of Nottingham University Exploration Society will participate as "subjects."

THE IES Report on the prevention of eyestrain in cinemas, which was published last Autumn, is not being ignored by local licensing authorities. But, as one would expect, its recommendations are not being immediately applied with such rigour as to cause hardship to cinema exhibitors. In Manchester, for instance, strict adherence to the limit of 35 deg. recommended for the angle between the horizontal line of vision and the line of vision to the top edge of the picture would mean the removal, or disuse, of about 6 per cent. of the total number of cinema seats in the city. However, the Report also recommended that in certain circumstances in existing cinemas a maximum vertical angle of view of 45 deg. might be allowed. If this recommendation is followed, it appears that the loss of seats will be reduced to about 2 per cent., but the Manchester Corporation may be even more tender-hearted to cinema owners than was the Eyestrain Committee.

HERE is the solution of the crossword puzzle I gave last month. *Across*: 1, Splay. 6, Snappy. 11, Phot. 12, Heep. 13, Ale. 14, You. 15, Ro. 16, Son. 17, Spread. 20, Light. 23, Spectra. 24, Lull. 26, RSM. 27, Miasma. 28, Sortie. 30, Friar. 32, Pre. 33, Pranced. 35, Verona. 37, Candela. 38, Knobs. 41, Ecru. 42, Everywhere. 46. Eire. 47, OTLVA. 49, Lira. 50, Inhale. 53, Luminaire. *Down*: 1, Spy. 2, Phosphor. 3, Loupe. 4, At. 5, IES. 7, No. 8, Pash. 9, Plot. 10, Yen. 12, Hoarse. 15, Retrieve. 18, RC. 19, Dam. 20, Luminance. 21, Iliac. 22, Glare. 25, Particular. 28, Spectacle. 29, Reindeer. 30, Fro. 31, Rank. 33, PRA. 34, Disc. 36, Elire. 39, Beetle. 40, Twain, 43, Vial. 44, ER. 45, Roar. 48, Le. 51, Na. 52, Hi. Fair enough? Of course, you noticed the translation of "*passim spargere lucem.*" And here is the second of my series of three holiday-month crosswords.



ACROSS

1 An illuminating lighting engineer. (6, 3, 4).
9 Instrumental in producing old MSS.
10 Of that which waxes and wanes.
11 No need for a Porta; it isn't heavy.
13 In the pools there are millions against you.
15 You may do this without being an undertaker.
17 As well as.
19 Strangely, has something tho' nothing to do with redeem.
20 Want of blood, according to Aristotle.
21 "Like Snow upon the Desert's dusty face —— a little Hour or two—."
23 Peruvian sovereign.
26 A kind of good sight the purblind may have.
30 The "evil eye" is no mystery to him.
34 What MPs of both parties sometimes do.
35 Almost its mirror image.
37 What he does so does a prism.
40 They say everything stops for this.
41 Not incompatible with the convex or the concave.
44 Where would lighting engineers be without him?
45 Maybe a useful fitment for cornice lighting.
47 One kind of creator but certainly not the great —— of the Universe.
48 Archaic perhaps, but has been modernized with a terminal aspirate.
49 Sometimes associated with Sally.
50 What Mrs. Gummidge was.

DOWN

1 He found a good use for grease spots.
2 They ornament the written word.
3 A sly look, maybe?
4 What every scientist collects.
5 Gray's ploughman did this on his homeward way.
6 What politicians often throw.
7 To say the —— of the Light Brigade would be silly.
8 Needed in health, but always found in disease.
12 The part of the face between the nose and the ears.
14 As the road is to the wheel.
15 Musically speaking, much the same as 8 down.
16 An occasional activity on Dartmoor.
18 Darkness in Paris or maybe Monte Carlo.
22 Often thousands of voices acclaim it.
24 A place of leisure? Not Pygmalion likely!
25 Would be in its element at Chequers, especially with the P.M. in residence.
27 A chocolate coloured one?
28 Both the optimist and the pessimist can help you here.
29 May be pleasant-smelling and used for flavouring.
31 Fit would fit but is not inappropriate.
32 Contraction of an archangel's name?
33 Did the colourful East suggest this obsolete term for the strength of colour?
36 1 across had first to do this.
38 They cannot produce their licence tho' they have it.
39 Playfully mischievous.
42 A surround, or even B.O.
43 "Out of the frying-pan——."
45 Undoubtedly associated with 39 down but may give 11 across and would 14 down mean anything without it?
46 You may find it if you break the soil.